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ON THE COVER

FLORIDA'S recent rapid growth in both population and industry has created a water-supply problem in many of its communities. The state is fortunately underlain by a bountiful storehouse of water that is generally of good quality but contains some salt that may in time become a source of trouble.

With a high point of only about 32 feet above sea level, Florida has to put its water reservoirs in the sky to get gravity distribution to consumers. Our cover picture shows a "watersphere" at New Smyrna Beach, on the east coast. Perched on a hollow steel column that tapers in diameter from 30 to 6 feet is a 30-foot ball. Its crown is 147 feet above the earth, an unusual height in that region and one that makes the structure's pleasing lines visible from afar. The sphere was designed and constructed by the Chicago Bridge & Iron Works.

Inside the supporting column are a ladder and a 10-inch riser pipe to carry the water up and down. Motor-driven pumps fill the sphere to within 30 inches of the top and then shut down automatically. When consumption reduces the water level to within 30 inches of the bottom, the pumps go on again. At high level, the water exerts a pressure of 60 psi at the foot of the riser pipe.

IN THIS ISSUE

THE name of Cameron is an old and illustrious one in the pump field. The little shop that Adam Scott Cameron opened in New York in 1860 has developed into a sizable factory at Phillipsburg, N. J. Virtually every unit built there, save for the small "off-the-shelf" types, is tested under simulated service conditions. Our leading article gives the details.

●

AUTOMATIC operation of sawmills, a fairly old story among the larger establishments, is now being extended to smaller mills. Mrs. Jean Mater, member of a family long identified with the manufacture of sawmill machinery, tells about it, starting on page 68.

●

A STRANGE sounding word is *caboose*. Webster says it comes from *kabuse*, a Middle Low German word. Regardless of that, cabooses have long fascinated small fry and a lot of adults as well. Roy E. McFee, a veteran railroad man, delves into their history and romance. Page 72.

●

LONG without incentive to work, the American Indian has never been a "ball of fire" for energy, but there are signs that he is yet going to carve himself a niche in the national economy. The Navajos, traditionally flock tenders and rug weavers, are broadening their activities appreciably. Page 80.

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G. W. MORRISON, *Publisher*
C. H. VIVIAN, *Editor* J. W. YOUNG, *Director of Advertising*
ANNA M. HOFFMANN, *Associate Editor* J. J. KATARBA, *Business Mgr.*
J. C. PIERCE, *Assistant Editor* FRANCIS HARTMAN, *Circulation Mgr.*
A. W. LOOMIS, *Assistant Editor* WILLIAM HEINS, *Foreign Circulation Mgr.*
D. Y. MARSHALL, Europe, 243 Upper Thames St., London, E. C. 4.
F. A. MCLEAN, Canada, New Birks Building, Montreal, Quebec.

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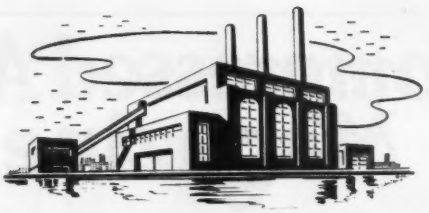
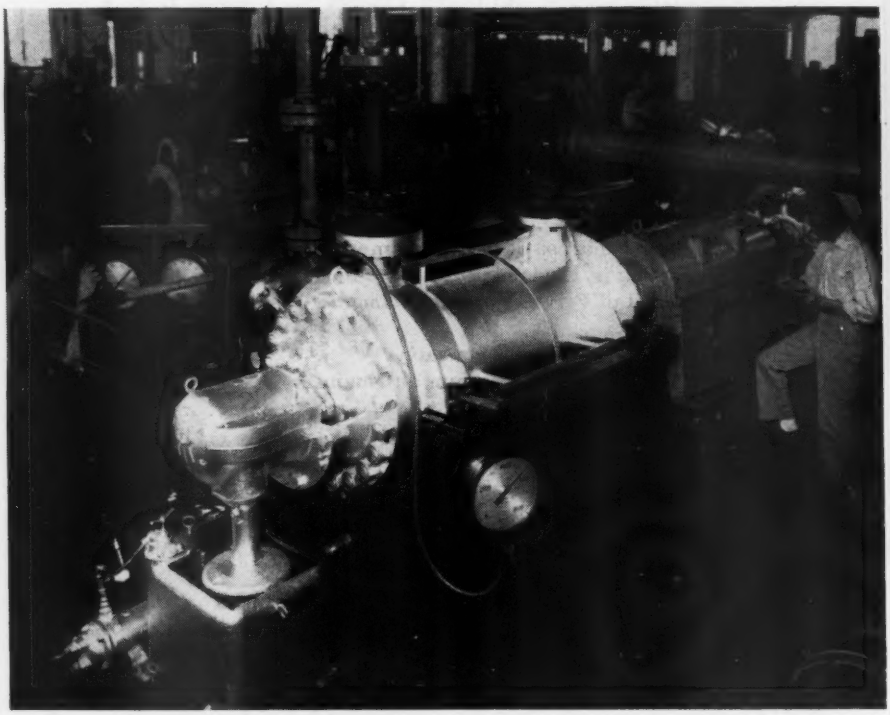


TESTING A HIGH-PRESSURE PUMP

In Industry's Finest Hydraulic Laboratory

G. B. Richardson



ON TEST

Engineers carefully check the performance of a 10-stage boiler feed pump as it is run under the same conditions it will be called upon to meet in the central generating station where it is scheduled to serve.

PERFORMANCE testing is an integral part of building pumps at Ingersoll-Rand Company's Cameron Division in Phillipsburg, N. J. A high percentage of the smaller standardized commercial units and virtually all the engineering pumps are given complete hydraulic and mechanical tests, the only exceptions being the few that are too large for the plant's extensive testing facilities and those that are identical with others on the same order. In the latter case only one of the group is tested unless the customer requests otherwise.

Despite the routine nature of this work, there was an air of unusual expectancy in the plant recently when a large double-case boiler feed pump was carried from the assembly area to the test pit's largest steam-driven dynamometer. For this unit, one of an order for six identical machines, was the highest-head pump built by this manufacturer to whom high-pressure units are no novelty. The design condition specified for the 6-inch, 10-stage unit of the CHTA Class was 1600 gpm at 2490 psi discharge pressure, with a total head of 6000 feet developed by the pump.

The men in charge of the setup and testing were aware of their responsibility —they knew that the completed pump in their care represented many months of labor and thousands of dollars worth of materials. To stand up under continuous operation with high-temperature, high-pressure boiler feed water, special steel alloys had been used in making its impellers, diffusors, shaft, sleeves and casing. With running clearances measuring only thousandths of an inch and a peak horsepower requirement close to 3600, the unit had to be lined up on the test stand with the same accuracy that would be required in its final installation.

So it was with caution that the workmen lowered the barrel pump onto the stand and wedged shims beneath its feet until the coupling halves of the unit and dynamometer were in alignment. After the mounting bolts were tightened, alignment was checked again, necessitating the removal of a shim here, the addition of another there. This painstaking procedure continued until the erection supervisor was satisfied that alignment was as near perfect as possible.

The intake and discharge pipes were led from the nozzles of the boiler feed pump to the 400,000-gallon reservoir underneath the Test Department. The intake line was piped through a Motorpump to provide positive suction pressure for the large unit, while the discharge line of high-strength carbon steel was connected to the Venturi meter system to measure capacities during the test period. The Venturi nests lie beneath the floor and are reached by a trap door and tunnel. Since the head would be nearly 7000 feet at shutoff, great care had to be taken in assembling and bolting the high-pressure flanges in the discharge line because the most minute wrinkle or flaw in the gaskets would cause leakage.

With the piping in position and the lubricating system for the pump bearings assembled, the unit was ready for the chief test engineer. He circled the huge machine, checking the piping and lubrication lines and making sure that all was in order to begin operations.

SOME TEST DETAILS

1– As preparations are made to put a CHTA high-pressure pump through its performance trials, Charles Jestrow bolts up the water discharge line.

2– Next he checks the alignment of the dynamometer drive coupling.

3– To start the test, he turns a valve that admits steam to the 3600-hp turbine that drives the dynamometer.

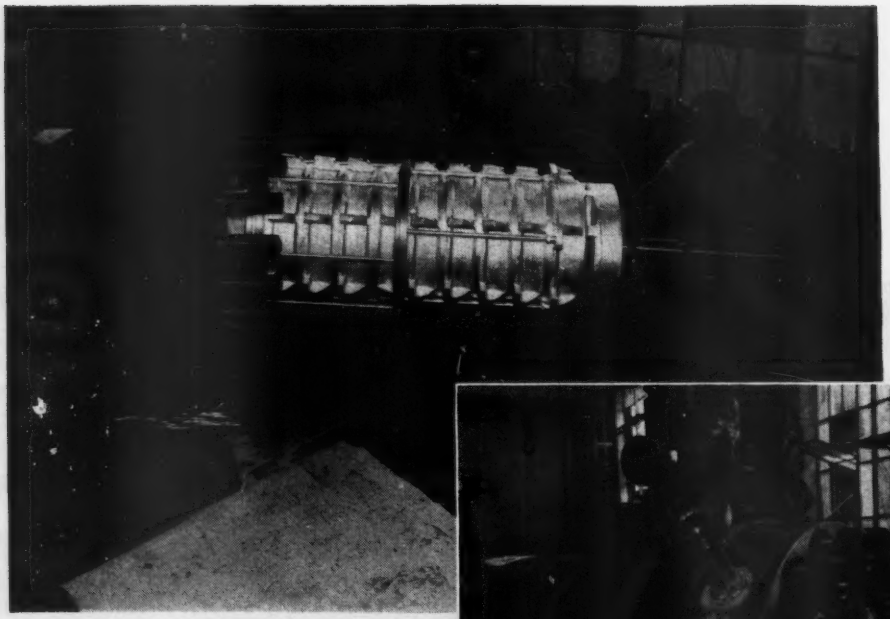
4– Bernard Gairman takes a manometer reading from a large Venturi meter that measures capacity. Revolutions per minute are shown by the tachometer at the left.

When everything met his approval he nodded to the man at the main steam-control valve, the signal to crack it and set the dynamometer turbine rolling.

This initial start of the ultrahigh pressure pump was the first tense moment, for it was then that the many individual efforts that had entered into the machining, inspection and assembly of the component parts of the pump were put to test and the rotor assembly was set spinning for the first time on its carefully adjusted sleeve bearings. A ring fit not perfectly concentric, a bearing lining low by a hair's breadth, one shim missing—any one of these shortcomings might have meant seizure of the closely fitted rotor. For no matter how carefully the inspection system is thought out and executed, the human element must always be reckoned with. But the pump picked up speed with a quiet hum, evidence of the skill that had entered into every phase of its manufacture.

The unit on the test stand was the aristocrat of the Ingersoll-Rand pump line—the result of more than three decades of experience in building such equipment for modern central stations. It was this type that had given power-plant designers free rein with feed-water pressures in their search for more economical means of power generation. The upswing in feed-water pressures started in 1922. Before that time generators and turbines had been smaller, and horizontally split, volute-type pumps had provided pressures of around 600 psi, maximum.

Paralleling the ensuing rise in pressure was the need for a 1200-psi pump that would insure dependable operation with minimum outage. Ingersoll-Rand's design to meet these requirements was called the HMT, and thousands of these machines were sold for boiler-feed service. Units of this class piled up records of performance and maintenance-free operation that are still unexcelled. It is not unusual for them to run for 80,000 hours without loss in head or capacity and without ever being opened for inspection. But the higher pressures made horizontally split casings impractical, and



ASSEMBLING BARREL PUMP

In the view at the left, the inner casing of a 10-stage boiler feed pump is being slid into the forged-steel outer barrel. Aldo Gobbi, right, eases it into place as Jerry Fallon checks the clearances. The other picture shows Fallon running on nuts with an Ingersoll-Rand No. 577 impact tool to put the discharge head securely in place. A ring of studs 2½ inches in diameter is required to hold the head against the pump's operating pressure of 2463 psi.

the steel-barrel double-case pump, now typified by the CHTA, was developed.

This type features a rotor assembly composed of individual channel rings, one for each stage, "stacked" like phonograph records and held together by through bolts for ease of installation and removal. In operation, these vertical channel-ring sections are in metal-to-metal contact, which is maintained by the discharge pressure exerted towards the suction end of the pump. The impellers and shaft sleeves are mounted on a heavy shaft which rotates within the inner casing assembly, the liquid flowing straight through the pump from suction to discharge. The whole inner casing assembly is placed in an outer barrel of forged steel to which the heavy discharge head is bolted. It was this casing within a casing that prompted the descriptive adjective of "double-case" for units of this type.

The hydraulics and design of a single-suction impeller create an axial thrust force which acts towards the suction of the impeller. In some types of multi-stage units the stages are opposed in equal numbers to cancel out these individual forces. But with in-line arrangement of the rotor, these forces act in the same direction and other means must be sought to place the rotor in axial balance. In the CHTA, this thrust force is neutralized by a drum which rotates on the shaft in a close-clearance bushing at the discharge end. At this point of highest pressure the drum and its sleeve form a passage along which the pressure is broken down. Since the back face of the drum is connected to the suction system, this pressure reduction is complete and the outboard stuffing box is under suction pressure, as is the inboard box. This, however, is a secondary advantage of the balancing drum because its principal purpose is to bring about the axial balance of the rotor assembly within the unit.

In service there is a continual but small flow of balancing-drum leakage from the high-pressure point through piping to the suction system. During the trial run, this flow is checked to make sure that clearances are properly proportioned and leakage is not excessive.

The first pumps of the double-case design in boiler-feed service were installed in the generating station of a Chicago utility company in 1941 and have a discharge pressure of 1600 psi. Some of the early ones were provided with cast barrels, but difficulties in obtaining sound barrel castings prompted the manufacturer to standardize on the forged-steel type for high-pressure application. Subjected to continuous service with high temperature, high-pressure boiler feed water, cast barrels sometimes developed minute leaks that could not be detected by means of normal hydrostatic tests. Forged barrels, made from a solid billet of high-carbon steel, have been found to be more uniform and resistant to the erosive action of feed water.

The proponents of higher pressures as the road to great economies reached a peak with the design of the Twin Branch station of the Indiana & Michigan Power Company, one of seven affiliates in the American Gas & Electric Company system. At this plant I-R boiler feed pumps, taking suction at 700 psi from low-pressure heaters, deliver water at 2900 psi through two stages of feed-water heating to the boiler. Most modern stations use pressures of more than 2000 pounds, but the trend towards ever higher pressures seems to have been arrested because the thermal economies made possible by extremely high steam pressures are offset by the higher heater, boiler and piping costs involved.

Since the modern CHTA pump whose performance we are following was to be driven by a 60-cycle induction motor, its speed was maintained at 3570 rpm by adjusting the steam supply to the turbine operating the dynamometer. During the time it took the unit to attain that speed the test engineer purged the manometers connected to the upstream and downstream sides of Venturi meters. These manometers are calibrated according to their particular Venturi throat characteristics to give direct readings of capacity in gallons per minute. Every

CAMERON TEST DEPARTMENT

This hydraulic laboratory is believed to offer unequalled facilities for testing pumps ranging from ¼ to 3600 hp at speeds from 100 to 8000 rpm, capacities up to 70,000 gpm and pressures up to 3600 psi. Water for testing is held in a 400,000-gallon reservoir under the floor. The basin is 9 feet deep and has double walls of concrete.

effort is made to insure accuracy, and the approach piping to the Venturis is long and straight to prevent eddies that might effect the readings.

The first operating point checked was that of capacity or design condition, which was 1600 gpm. To this end, the test engineer signaled one of his assistants to adjust the heavy 4-inch steel discharge valve until the required manometer reading was obtained. Readings then taken simultaneously were revolutions per minute from an electric tachometer, torque in pound-feet from the dynamometer, and head in feet as indicated by the suction- and discharge-pressure gauges—data needed to plot the head-capacity, horsepower-capacity and efficiency-capacity curves for the pump.

As other points (1200, 900 and 600 gpm) were checked successively by slowly closing the discharge valve, the tension on the test floor increased. At these reduced capacities the noise caused by the pressure breakdown across the discharge valve is like that made by a machine gun. To the uninitiated it is seemingly an operational phase, but to the experienced engineer's ears it is separate and distinct from the machine's even purr, which he listens for subconsciously throughout a run.

Finally, the crucial period arrived—shutoff. At this stage of maximum head the discharge valve was screwed shut and the shutoff horsepower delivered to the pump by the turbine was absorbed by the 50-odd gpm of balancing drum leakage, the only flow through the unit. The test engineer moved quickly, checking his tachometer, torque reading and pressures in a few seconds—all that it needed to raise the temperature of the water some 100°F. Had the discharge remained closed too long, the water would have become overheated and flashed into steam, making the lubrication of the running clearances ineffective and probably causing rotor seizure. In actual service, when a pump is finally installed, this danger is avoided through the use of a minimum flow line in which an orifice lets enough liquid pass at shutoff to keep the temperature of the water in the pump at a safe degree.

With the data taken, signal for opening the discharge was given — notice that the test was completed — that the turbine could be closed down and the pump stopped. No matter how many times the men on the test floor have gone through the shutoff period in the case of a high-pressure unit, there is always the same feeling of relief when it is over, for not one of them underestimates the terrific power pent up in water that is under a pressure of 3000-odd pounds with no place to go.

Final checks were made of the temperature of the bearing housings. These are water-cooled in service, but for the 20-minute run were not equipped for cooling in order to detect any abnormal heating of the bearings. Then, with his rough data, the chief engineer went to his office to plot and check the performance curves that would indicate the horsepower, efficiency and hydraulic

FACTORY BAY

Parts for casings for the larger Cameron pumps flow smoothly along an orderly line-up of machine tools. On the assembly floor elsewhere in the plant they meet the shafts and impellers, which have been machined in another department.

characteristics of the pump. Minutes later he came back to chalk "Test O.K." on the steel side of the quiet machine. With satisfaction the men started to dismantle the piping and remove the pump from the test stand, for some refinery units were to be tested that afternoon.

After its return to the assembly department, the barrel pump was drained and filled with a rust-preventive oil preparatory to shipment. That done, it was covered with insulation and finished with sheet-metal lagging to give it a modern, smooth exterior. Mounted on a 15-foot steel baseplate and fitted for the motor driver, the machine was painted silver and blue and placed on a flatcar for its trip to the utility's plant. Though it might have to sit for months awaiting final installation, the measures taken will protect the rotor from damage.

In all, the Cameron Division's Test Department has nine test stands: one on each end of three steam-driven dynamometers and one each for three variable-speed direct-current dynamometers. The electric stands are suitable for pumps within their 25-, 100- and 150-hp ratings; the turbines on the dynamometers are rated at 1000, 2400 and 3600 hp. The smaller one has a top speed of 8000 rpm and the others run at speeds up to 4000 rpm.

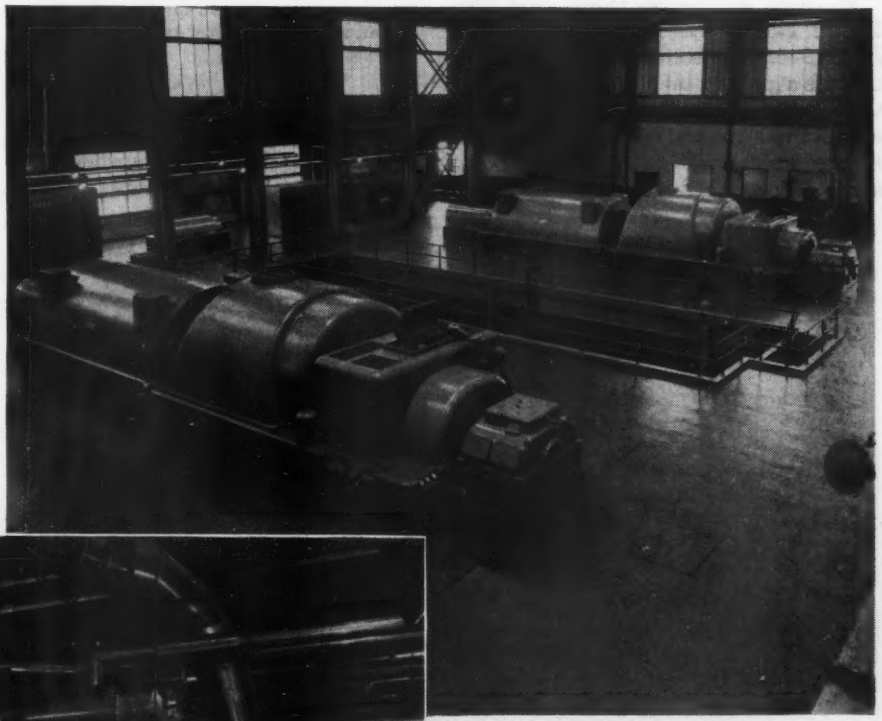
Vertical pumps are tested with calibrated electric motors. If desired, model tests can be made of ultralarge machines, and through the use of governing formulae it is possible to predict actual performances of finished units. Facilities are also available for testing pumps which are designed to operate under low submergences. A big pressure vessel, which can be evacuated to any desired degree, is the source of the suction for the condensate and refinery units most commonly found in service of this kind.

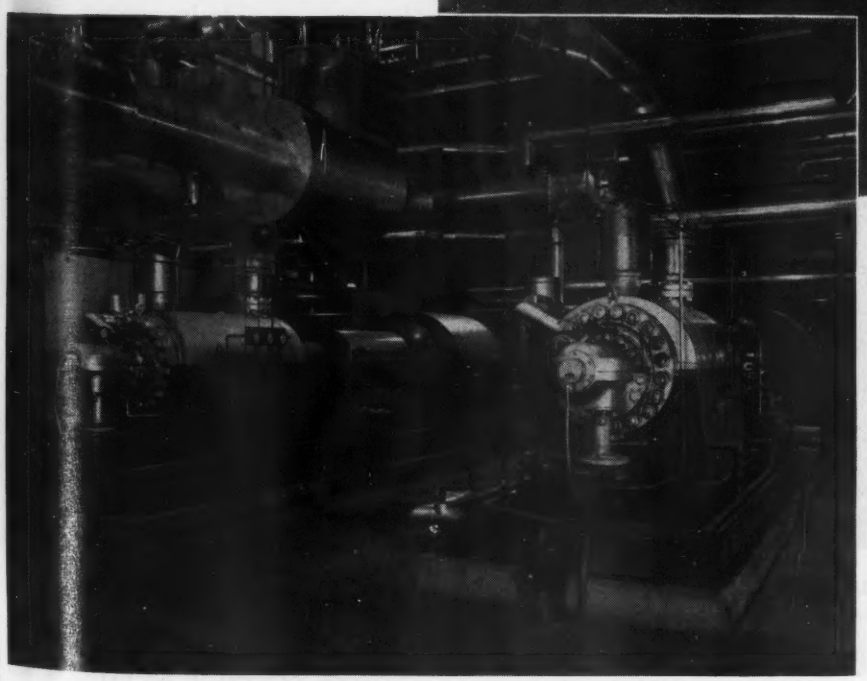
In another building, separate from the Cameron plant for reasons of safety, pumps for the refinery and process industries can be tested with the hydrocarbons they will be called upon to handle. Propane, kerosene and gasoline may be substituted there for the clear, cold water used on the main test floor. In addition, extensive research is carried on in this isolated structure to determine the performances of mechanical shaft seals and various other stuffing-box arrangements with volatile liquids.

Some years ago, Cameron Division engineers developed a special setup that would permit them to run endurance tests on a shaft seal they had produced in response to industrial demand. Known as the Cameron Shaft Seal, it rapidly gained acceptance, and today is in worldwide use as a solution of many difficult stuffing-box problems. Innovations in design for unusual applications are still thoroughly tested.

Cameron's test facilities are undergoing continual improvement. One interesting project now in hand is typical of the care taken to insure accurate results. At present, pump speeds are checked with an electric tachometer which uses 60-cycle current as power and as the calibrating reference. Because this current, which is supplied by the local utility, is subject to slight fluctuations in frequency at certain times of the day, a piezoelectric crystal inverter has been obtained to provide the tachometer at all times with current of exactly 60 cycles.

Accurate performance tests are important to the customer and manufacturer alike — to the customer because they are assurance that the unit purchased will meet its guarantees and do the job — to the manufacturer for the same reasons, plus the knowledge that the pump shipped will add to his reputation. A laboratory well equipped for production testing and operated under carefully controlled conditions is by far the most practical means of achieving these ends.





PUMPS IN SERVICE

Shown above are two 80,000-kw turbogenerators in the Titus Station of Metropolitan Edison Company, at Reading, Pa. Ten years ago these units would have been among the largest of their kind; today they are about the average size built for central-station service. Along with the growth in generator ratings there has been a continual trend towards utilizing steam at higher temperature and pressure. This, in turn, calls for greater capacity, more dependable boiler feed pumps. Each Titus generator has its own boiler, and the latter is supplied with water by an Ingersoll-Rand 10-stage motor-driven pump. Two units (left) are provided, one being in reserve. Each can deliver 1211 gpm against 3980 feet of head.

Push-Button Sawmills

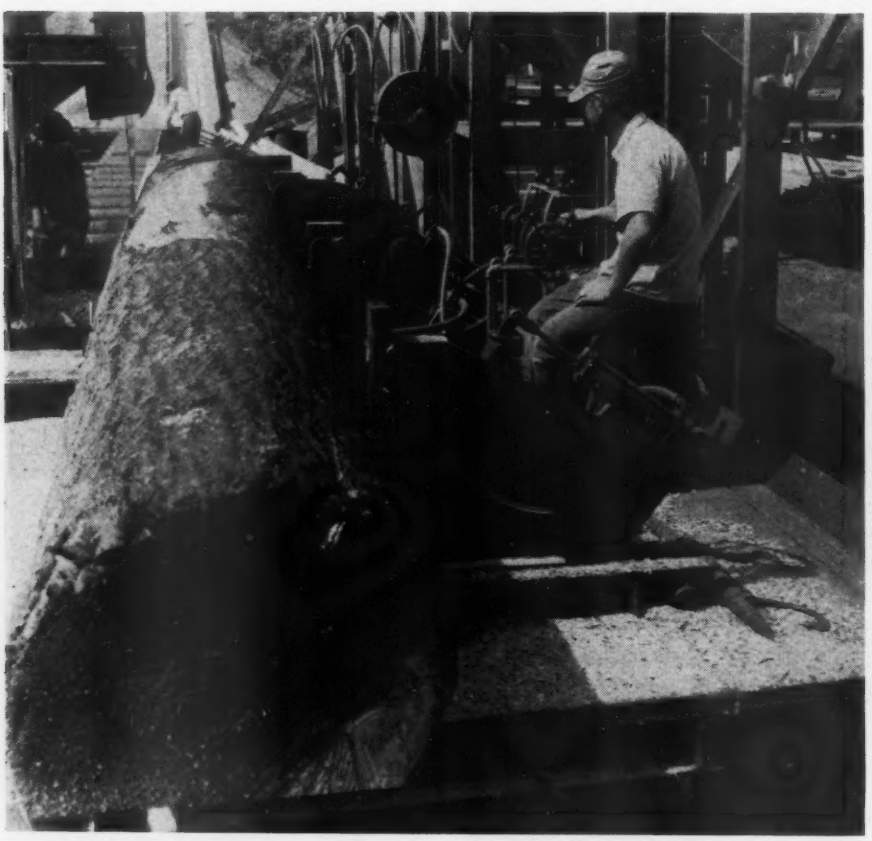
Compressed Air is Helping to Bring a New Era to the Lumbering Industry

Jean Mater

RIDERLESS CARRIAGE

In this nearest approach to an automatic sawmill, the sawyer controls the entire operation. On the carriage at the right are three knees against which the log to be sawed is firmly held by steel prongs or "dogs" on descending arms. After each cut the knees push the log over the width of the board to be sawed. Both knees and dogs are set by air cylinders.

THE number of sawmills in the United States, most of them located in the Southeast and the Pacific Northwest, has almost tripled since 1940. The last nose-counting came up with a grand total of 53,000. Many of these are giant mills, employing thousands of workers and turning out enough finished lumber every day to build thousands of homes. But most of them are small or medium-sized businesses, supporting from two or three to perhaps 15 or 20 men and producing anywhere from 5000 to 75,000 board feet a day.



ONE-MAN CARRIAGE

Originally manually operated, the carriage has been converted to semiautomatic operation by the addition of air cylinders, controls and accessory equipment. The setter, riding the carriage, has a hand on the controls of the cylinders that power the knees and dogs.

The giants, because of their magnitude, were compelled years ago to mechanize. At first steam was utilized as the sole motive force for handling logs and powering the intricate mechanisms that turn rough logs into finished boards. Then compressed air, electricity and hydraulic power replaced steam in many of the more modern sawmills and every effort was made to substitute machine for handwork to achieve greatest production at lowest cost.

Not so, however, with the multitude of small and medium-sized mills. Until World War II it was cheaper to hire men than to invest in machinery, and few attempts were made to mechanize them. In fact, many millmen held to the notion that new-fangled gadgets like pneumatic "dogs" could not do the job a couple of men could do. But the war changed that picture. After it was over, it wasn't easy to find and keep a sawmill crew. Wages rose; employee service duration decreased; the cost of turning a log into boards soared. Operators found that in order to survive they had to find ways of cutting down production costs and doing without the men they could not hire.

Mechanization was the answer, of course. Compressed air played a major role in bringing that about because it enabled mills to cut more lumber at less cost. But recently, with the application of remote-control mechanisms designed to operate compressed-air systems, push-button sawmills have become a reality and mechanization has reached a still higher point. Just what this revolution means in sawmills of moderate size can be appreciated only by comparing the methods followed in an old-style mill

with those practiced in a modern plant.

In the traditional prewar mill the sticks are hauled up to the log deck from the pond or from the "cold deck," depending upon whether cutting is done wet or dry. There two or three men with peaveys and poles laboriously roll them, one by one, onto the sawmill carriage. Workers called doggers run back and forth on the carriage, operating steel dogs which bite into the wood and hold the log tight against steel knees. Now the carriage is ready to roll forward into the saw, which cuts off a board with each forward thrust.

The movement of the carriage is directed by the sawyer, an expert who stands in a pit near the saw. Upon a signal from him, the setter, who rides on the carriage with the doggers, pushes the log out as required to cut boards of a certain width. As the boards are sliced off, they are run through the edger to smooth the edges and then transferred to the "green chain" where they are graded, sorted and stacked for shipment.

That, briefly is the way in which a typical medium-sized mill is run. A cutting of, say, 50,000 board feet a day may need as many as three men on the log deck, two doggers and one setter on the carriage, a sawyer, an edger and five or six green-chain men. With the steam crew and maintenance gang, the total would be around twenty, or 2500 board feet per man per 8-hour day.

Now, supposing the sawmill operator looks over his accounts and decides that he must turn out at least 4000 board feet per day per man to keep his mill in the black. Or supposing he can't hire the twenty men required to run it. Then he modernizes. One of the first steps he takes is to convert the dogs from manual to air operation, thus dispensing with the services of the doggers. Now the setter does the dogging through the medium of a manifold and valves within convenient reach of his seat.

The millman may even go a step further and set the air dogs by remote control through electric solenoid valves. In that case the sawyer does both the setting and the dogging from his position in the pit—no one rides the carriage. Economy of operation is only one advantage of the riderless carriage, as it is known to the trade. Greater accuracy in cutting is also frequently achieved. Extremely important is the fact that changeover to air power has eliminated some of the most dangerous jobs in the lumber industry. Riding a carriage which rockets back and forth at the rate of 600 to 700 feet per minute is not easy on a man's constitution and is a hazardous job, at best.

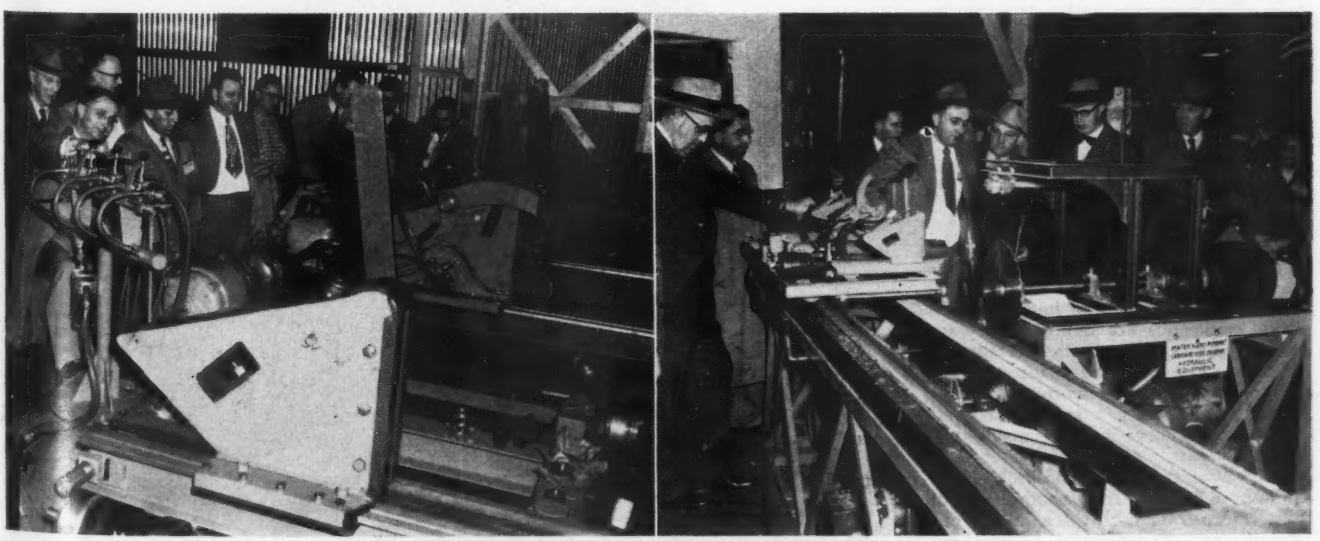
With the carriage completely mechanized, the operator next looks to his log deck and provides air-powered mechanisms by means of which heavy logs—averaging about 14,000 pounds in the Douglas fir mills and 7000 pounds in the pine mills—can be rolled onto the carriage, turned, lifted and moved at will with no muscular strain on the part of anyone. Again, the sawyer takes over and does everything by remote control. In short, the heavy manual labor that used to call for anywhere from three to six strong backs is now done by merely pushing buttons or turning valves.

From all this it would seem that mechanization of medium- and smaller-sized mills is an accomplished fact. Actually it has not reached that stage; the revolution is only now getting underway. Many manufacturers of sawmill machinery are still building manually operated carriages. But the demand for air control has grown so rapidly that one western concern, which pioneered in and introduced pneumatic equipment to many Pacific Coast mills, now does a brisk business making air-dog kits with which it is easy to convert carriages from hand to air operation.

Other symptoms of the trend can be found in the lumber periodicals. Most of the questions answered by the Engineering Clinic in the *Western Forest Industries Review*, for instance, concern air power in sawmills. A well-known southern periodical recently carried an article on the mechanization of dogs through the medium of compressed air, a subject that aroused considerable interest there because the compressed-air revolution originated in the Pacific Northwest where the labor situation was tightest and only this past year began to spread eastward.

Air operation, particularly by remote control, is still so new to most millmen that one manufacturer built a working model of one of his sawmills to show them that it really is effective. A one-quarter scale duplicate of a full-sized modern mill, it actually saws small logs and permits observers to play the part of sawyer—to control the work from start to finish. When exhibited at a convention, it attracts a big audience and makes converts out of skeptics who wouldn't believe it if they hadn't seen it with their own eyes.

While the adoption of air power in small and medium-sized mills is well underway, it has not nearly reached its peak in sawmills generally, and there is every reason to expect that time and ingenuity will widen its usefulness in this fertile field.



VIEWING NEW EQUIPMENT

The revolution in sawmill operating methods is under full headway but there are still many small millmen whose plants remain unchanged. The group at the left is looking at modern log-handling machinery powered by compressed air. The manifold control station is in an elevated position (left) with air hoses leading to pneumatic cylinders. As an aid in selling the new equipment, the Mater Machine Works, an Oregon sawmill manufacturer, has built a working model of a "push-button" mill (right) that makes the rounds of conventions and trade shows.

Compressed Air at Work

Compressed air blowguns are used in countless factories for removing chips, but something new has been added to them at the C. A. Norgren Company plant in Englewood, Colo. Eugene O'Mara, an assembly-line worker who uses a gun often, conceived the idea of putting a clear plastic guard between the body and the removable tip of the tool, as illustrated above. The idea was suggested by the fact that plastic disks of suitable size and shape serve as baffle plates in Norgren air-line filters. The blowgun guard deflects flying particles away from the operator's eyes without obscuring his vision of the work. The Norgren management finds it easier to put guards on all plant blowguns than to enforce the wearing of goggles, and the new device is effectively preventing eye injuries.

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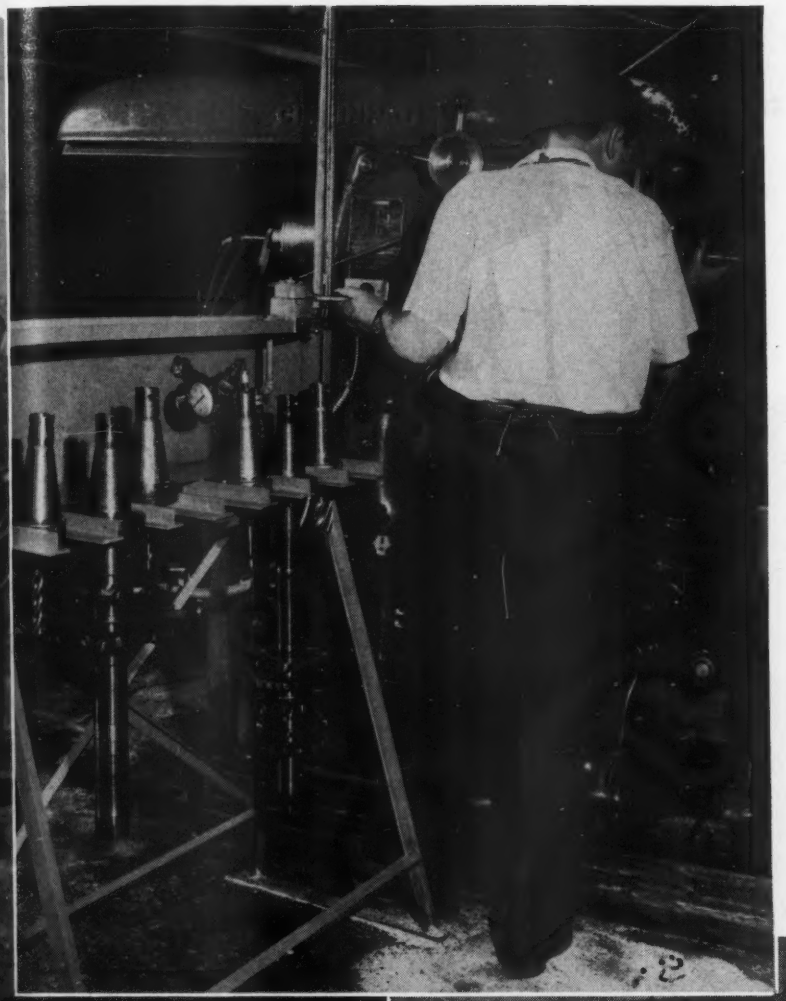
Following the development of a low-melting-point alloy wire called Spraymore, complex molds for forming some kinds of plastics are being made successfully and quickly by the metallizing process. The wire is fed through the oxyacetylene flame of the gun, and as it melts progressively a stream of compressed air sprays it on a master pattern. A layer 0.04 inch thick is applied and is covered with an 0.03-inch film of aluminum bronze. Then another coat of Spraymore 0.04 inch thick is laid on. Metallizing Engineering Company, which manufactures the outfit, states that a mold has been produced in this way in 28 minutes. The forms are suitable only for low-pressure or vacuum-molding.



The Texas Engineering & Manufacturing Company, Dallas, Tex., has a job that calls for a diversity of milling, boring, center-boring and reaming operations at very close tolerances. Altogether, ten changes in arbors are required. Because the assembly is too heavy to be moved readily, all the work is done on one machine. Realizing that the schedule could be met only by finding some way of changing arbors quickly, the problem was solved by an air-operated drawbar that has reduced the average time from 3 minutes to 10 seconds. The picture at the left shows the milling-machine operator changing an arbor on the drawbar, which is powered by the 6-inch air cylinder seen at the left projecting from the machine. Six other arbors are arranged in a line on a rack at the left.

•

At the Coca Cola bottling plant in New Haven, Conn., returned wooden bottle cases are cleaned in the cabinet pictured below. Borne on a conveyor that is equipped to grip their sides, the cases are carried up and around, inside the enclosure. When each is upside down at the highest point in its travel, blasts of compressed air from four jets are directed into it to dislodge dirt or other debris, which falls down and is chuted out through the rear wall. Having completed the circuit, the cases are released by the grippers and carried out of the cabinet. Two men formerly beat the cases manually as they passed by them on a conveyor. This was slow work and hard on the carrier. The machine, made by Standard-Knapp Division of Emhart Manufacturing Company, Portland, Conn., handles 30 cases a minute without attendance.

Liberia, a country in tropical Africa about the size of Kentucky, has instituted a 5-year development program to be carried out with the assistance of United States funds. Construction of roads, bridges and power plants and the improvement of agriculture to increase the food supply are the principal aims. Of prime importance, also, is the raising of the public-health standard, and $7,700,000 has been allocated for that purpose. One of the first steps in this direction is the spraying of stagnant water with hand air-pump equipment (above-left) to kill malaria-carrying mosquitoes.

The Century-Old Caboose

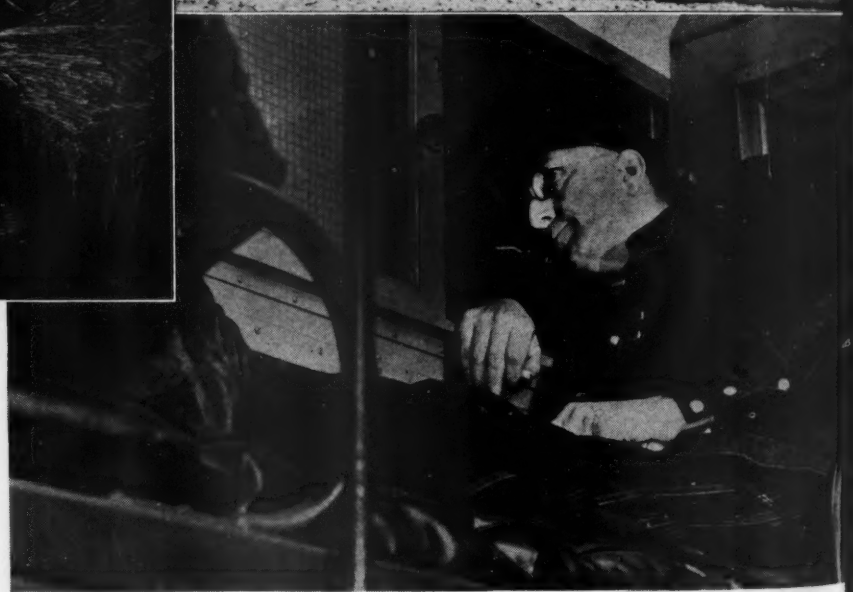
Story of the Stubby Little Car at the End of all Freight Trains

Roy E. McFee

PICTURES AT LEFT MARGIN FROM BETTMANN ARCHIVE. ALL OTHERS FROM ASSOCIATION OF AMERICAN RAILROADS

RAILROADING IN 1877

Before air brakes were standard train equipment, brakemen had to climb on top of cars to apply hand brakes, regardless of weather conditions. After such a siege, the comforts of the caboose were much appreciated.



REST AND VIGIL

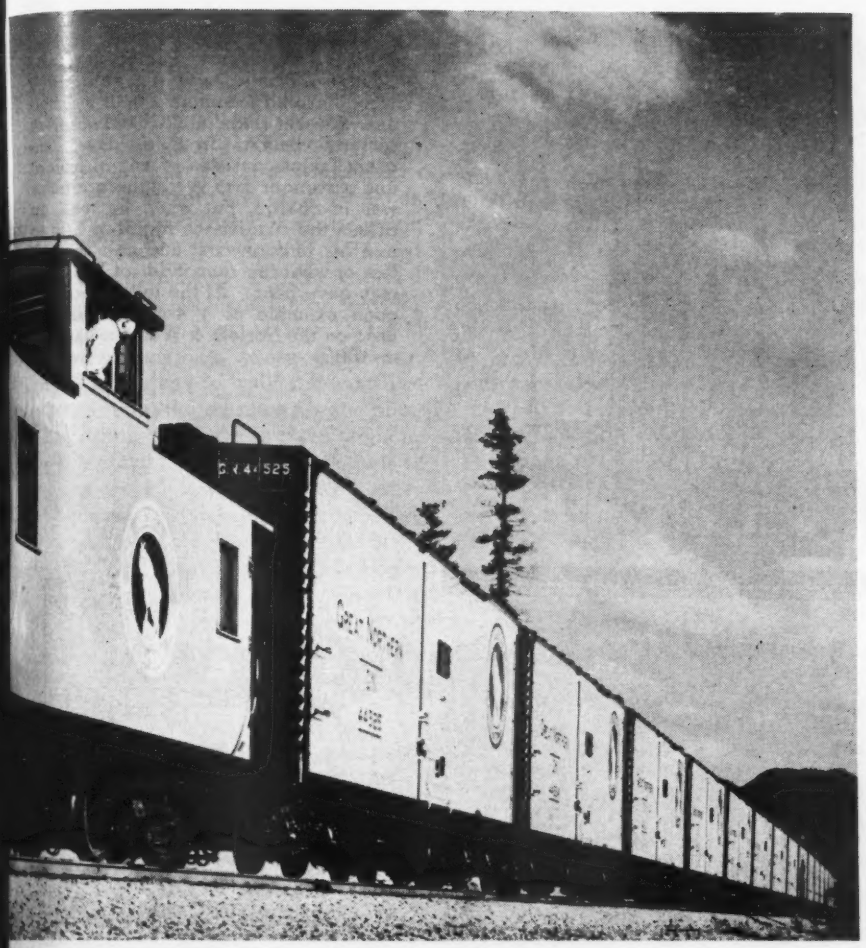
A flagman on the New York, New Haven & Hartford reclines on a bunk in the cupola of a caboose but has an eye on the cars ahead.

IF YOU are a normal man or boy, any manifest freight train streaking through the countryside is certain to catch your eye. The modern diesel, with its horn sounding, bursts around the foot of a cliff pulling a string of freight cars perhaps well over a mile long. Roaring down the river bank at a pace of possibly 70 miles an hour, the train goes by in less than 60 seconds. As it disappears around the next bend, your final glimpse takes in the fantastic-looking car on the end.

Except for the locomotive, that last car—the caboose—has probably captured the imagination more than anything else in railroading. Somewhat shorter than an ordinary freight car and usually red or orange-red in color, it has friendly smoke drifting from its homemade stack. Maybe a face peers from a lower window or the cupola. And altogether your heart is stirred a little by the drama in the speed and far places of the railroad world.

As is to be expected of anything mechanical, the caboose has been undergoing changes, especially in the last fifteen years or so. Occasionally, therefore, the end car rumbling along is not red but aluminum with golden-yellow trim. And instead of a cupola it has two bay windows. But whatever the superficial alterations, its nature is not much affected.

Why has a freight train always a caboose, following sometimes 150 boxcars, flatcars, tank cars, hoppers and gondolas? First of all, it is the field office of the train, whether standing or moving. It is the headquarters of the conductor, whose word is law on the train. But it is also shelter, bunkhouse and traveling quarters for the crew, and often the kitchen and dining room as well. It likewise serves as tool house and observation



ALL'S WELL

As a Great Northern freight train clicks along the rails in the mountainous West, a trainman keeps watch from his vantage point in the cupola of the caboose. The car's superstructure is built of plywood and has broad windows that face in all directions.

post. Hence a string of freights, even with a locomotive attached, is not considered a train until the caboose is coupled on. In the minds of railroad operating men it has always been a prominent feature and is called by an amazing array of names such as cabin car, buggy, chariot, gocart and glory wagon, as well as kitchen, diner, palace and pavilion. With the passing years there will probably be others, but caboose, of course, is the official designation and will survive.

The caboose undoubtedly had its beginning back in the first days of the railroad, for records show that in 1837 a freight conductor, with a run between Syracuse and Auburn, N. Y., felt the need of an official station for himself. So he chose the last car of his train and signaled orders from a seat high on boxes and barrels. That seems to have been the preliminary step in the creation of an office car for a freight train. Allowing another fifteen years for actual development, the caboose would, accordingly, be about 100 years old. The name caboose is nearly as old. It was certainly used as early as 1855 on the Buffalo, Corning & New York Railroad. At that time it had still other names—dignified ones—such as conductor's car, train car, accommodation car, and way car.

The cupola apparently dates from 1863. It was conceived by another freight conductor, T.B. Watson of the Chicago & North Western Railway. With his regular caboose in the shop, he temporarily used an old boxcar that happened to have a large hole in the top. That gave him an idea. Under the opening he built a crude bench on which he could sit with his head and shoulders above the roof. As he had expected, the lookout gave him a commanding view of his train and vantage point for issuing orders.

He tried the makeshift out in railroad yards at Clinton, Iowa, and found it not only efficient but also a lot of fun. He soon had a fascinated audience of fellow workers and railroad enthusiasts. Delighted shouts would go up as his throne car rumbled across the diamonds and through the turnouts, with occasionally a lordly bow from himself. But the experiment finally intrigued him so much that he went to the company's master mechanic and suggested a glassed-in clearstory as standard practice for future cabooses. As a result, two such cars were built that year in the shops at Clinton. The cupola quickly became an indispensable part of every caboose and continued so until 1923 when an Ohio railroad adopted bay windows set in the sides of the car. The Baltimore & Ohio also developed cabooses of that type in 1930, and since then bay windows have taken the place of the cupola in the more modern cars.

Over the years the caboose has undergone all manner of changes. It always has been the most eccentric item of all the rolling stock. On different railroads you will see types varying widely in arrangement and construction. Even those belonging to one road, standing together on their track at an engine terminal, are dissimilar. The older cabooses differ in length and are shorter than the ordinary freight car. Most of them have a cupola, generally at the center but sometimes at one end, and they, too, vary in design and general appearance. Perhaps the crudest caboose, excepting Watson's, was a boxcar with a 2-way bench on top unprotected from the weather. That piece of rolling stock was actually used until recently by the Chicago, Rock Island & Pacific Railroad for switching in its Chicago yards.

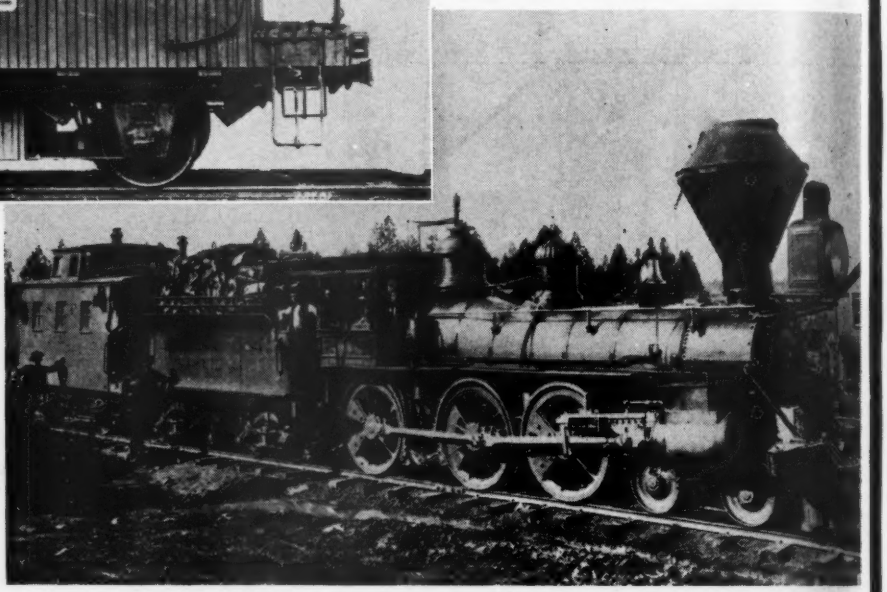
There is, of course, a reason why cabooses differ so from one another. Unlike the usual freight car, it does not travel on foreign lines—stays strictly on the home rails. The freight had to be standardized so that, no matter where it might be, it would fit into the transportation system. But no such restriction is imposed on the caboose. It can be as individual as it wishes, provided it has a standard-track gauge, couplings and air-hose connections. In spite of the trend towards modernization, the early type is still seen everywhere. It is still red in color, has a wood body and is about 35 feet long, from face to face of the couplings. It contrasts sharply with the twentieth-century diesel which may be pulling it around a railroad yard.

The cupola of the older caboose rises 3 or 4 feet above the roof that is reached by steel ladders from end platforms. A climb up these outside ladders reveals a roof walk along the ridge, also grab irons on top of the cupola. The latter is nearly, or sometimes fully, as wide as the car body and generally has eight windows. There are two at each of the four corners, one on the end and one on the side.

Back on the ground again, we notice a large toolbox suspended under the car between the trucks. It contains rerailing frogs, jacks, chains and other heavy equipment needed for emergency use. On the side of the caboose is its serial number and the name and emblem of the owning railroad. Walking up the steps to one of the end platforms, we observe the hand brake and the air hose and find a storm door outside the regular door,

FOUR-WHEELERS

In 1890 the Central Pacific, now the Southern Pacific, was still running a wood-burning locomotive built in 1868 and a 4-wheeled "dinky" caboose, as pictured below. In these days, Emigrant Trains consisted of mixed freight and passenger cars. A freight conductor was in charge, but when he took up tickets the regulations required him to don his uniform coat and cap regardless of what the remainder of his attire may have been. At the left is shown a good example of a 4-wheel caboose used on the Norfolk & Western Railway in 1893.



both with glass in the upper half. The body of the car is just high enough for comfortable clearance under the timber roof joists and crossbeams. The wall and ceiling finish is probably a pale gray-green, and the tongue-and-groove floor boards are most likely painted dark red. There are certain signs of housekeeping care, and we worry whether our shoes have carried in cinders.

If the weather happens to be cool, the caboose may be pleasantly warm from a low fire in the coal-burning stove with its flat top and two circular lids suggestive of a kitchen range in a farmhouse. A combination poker and lid lifter stands handy, and there is a protecting sheet of metal under the stove and one on the wall behind it. The shining stovepipe may be the only new thing in evidence anywhere. Above and a little beyond the stove are two clothes lines, and behind it the caboose mop is drying.

Dominating the room is the conductor's desk, usually built in place on one side or at one end. Its broad expanse gives ample space for papers and elbows. Two mantel lights with shades are bracketed low over it, and we detect a slight trace of kerosene in the air. Large drawers contain forms for reports, and two comfortable armchairs remind us of the country schoolroom of our boyhood.

Prominent among the furnishings are three or four bunks, either built in or made to fold up against the walls. The kitchen equipment includes a sink, a cold- and a hot-water tank, a food container and an icebox. Cabooses assigned to long runs carry stores of nonperishable food, inexpensive dishes and unpretentious bedding. A third mantel lamp is bracketed over the sink, and dark-green shades that are drawn horizontally across the small windows complete the homelike atmosphere. Directly under the cupola and on both sides of the center aisle are solid banks of wooden lockers and cupboards for supplies, work clothes and equipment, and in lockers near the door where they are handy are kept such operating items as gloves, boots, jackets and lanterns of varying sizes for different uses.

Ladders with grab irons are provided to permit climbing over the lockers into the cupola. If the latter is of an early type it has two bunks without springs, one one each side. Probably the crew has managed to get a couple of extra mattresses so the double thickness will make things a little more comfortable for them up there above the roof of the train. But if it is of a later design, the two bunks will be replaced by four chairs, a pair on each side, one facing forward and the other back. From those seats trainmen command a view out of the eight windows over the top of the train and even along the sides on curves.

Climbing down once again, we notice a few more items. Hanging on the walls near the doors of the caboose are red flags, signal fuses and a fire extinguisher. Pendant in the center aisle is the conductor's pressure gauge, and within reach is the brake valve by which he can stop his train in dire emergencies. Close under the ceiling is suspended a stretcher, a reminder that a freight conductor and his men have to meet many situations. As we are about to leave, we pause to reflect that a caboose, with years of service to its credit, has seen everything of railroad life — has been lived in continuously by a succession of railroaders — has traveled much and been to many distant places.

Taken as a class, whether old or new, the caboose is the nerve center of a freight train. At his desk the conductor writes reports and gives orders. There he spends long hours on paperwork, often toiling through the night. Meanwhile others of the crew, stationed in the cupola or at bay windows, watch the train ahead, particularly on curves to detect possible hot journals.

Today, as always, the coffeepot on the stove is symbolic of the social life of a caboose. Where length of run and conditions generally call for meals en route, brakemen have actually been chosen because they are good cooks. Although the car is no longer exactly the home of the crew for 24 hours a day, the men still use it as a sleeping place somewhere in the railroad yard during daylight hours.

Conductors often manage to have particular cabooses assigned to them. In cases of that kind the end car takes on the semblance of a permanent establishment, complete with radio and, perhaps, a fishing rod and gun standing in some corner. On quiet, unhurried lines passing through wilderness areas, trains have

been known to stall frequently in isolated spots where trout fishing is good or deer or pheasant hunting promising.

Because the caboose is the command car of the conductor, it has always played an important part in train communication. This is true of the early model as well as of the modern one now appearing on some roads. In the old-fashioned type, communication is primitive and more difficult for the conductor than for the engineer who can, at least, whistle standard signals back to the conductor. But the latter has to walk the length of the train and shout orders to the engineer or swing his lantern. Even when he uses a lantern he often has to climb to the roof of the car, particularly on a curve where the view may be blocked. He can always stop a moving train by operating the air valve in the caboose. But if the train is going fast, that method might tear it to pieces and put equipment into the shop for repairs. Difficulty of signaling has sometimes resulted in a train pulling out without the conductor. A more exasperating experience can hardly be imagined by him.

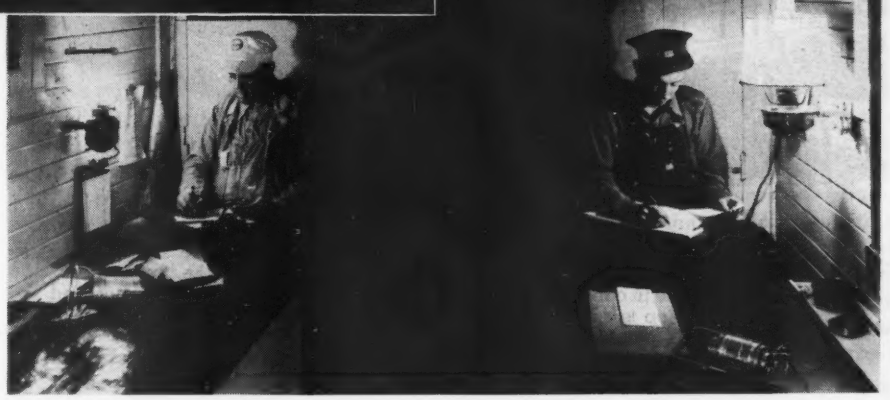
For the past 30 years, however, train communication has engaged the attention of the railroads and today is nearly what one would expect it to be in this era of science and invention. The modern freight train is provided with a telephone that enables the conductor to talk with the engineer in his cab, with railroad operating men at points along the right of way and also with crews on other trains. This means, of course, that he can issue orders and give as well as get reports. Often he can talk to the division office at headquarters from his moving caboose. This development did not come about overnight, and so far only a small percentage of our freight trains are equipped to carry on conversations by either space radio or inductive train communication.

Most of the cabooses bumping along the rails today are still of the old type, flashing the familiar gaudy color, carrying a cupola on the top and housing old-fashioned appointments. This is the kind we usually see even if the train is pulled by the latest diesel and some of the cars are up-to-the-minute boxcars or possibly 8-axle heavy-duty flats. But occasionally one rolls past that is artistically finished in reds and yellows combined variously with black, white or aluminum. Instead of the cupola it has two bay windows, one on each side in the middle of the car, with large glass panels facing in all directions. Whereas the cupola affords only a limited roof-top view and necessitates climbing a ladder, the trainman can go from one window to the other in a few quick steps and get a good view of either side, especially of the journals and boxcar doors.

In 1942 the Great Northern Railway completed twenty cabooses in its shops that were designed to give train crews greater safety, comfort and convenience on the long haul through the Rockies. The cupola was retained, but other features were ahead of the times. They are protected against extreme heat and cold by extra-heavy insulation, car windows are of double glass, and the upper glass panels of end doors are shatterproof. Light is provided by Aladdin lamps, and two water coolers, two conductor's desks, and a toilet room have been added to the furnishings. The entire interior has been streamlined to eliminate dangerous sharp corners and is finished in varnish-coated natural wood, with deep-red enamel on the floor. The exterior is bright red with gold lettering and black trim, and the underframe and trucks are black.

Also in 1942 the National Steel Car Corporation built eight cabooses for the Temiskaming & Northern Ontario Railway. These likewise have the roof-top lookout, are heavily insulated and include a locker for bed linen. The body is of Dulux aluminum lettered in black on a golden-yellow panel with a black border. Platform railings are painted signal red, inside walls are light blue-gray, the ceiling is cream and the floor terra-cotta red. In the same year seven steel cabooses were delivered to the Clinchfield Railroad by the American Car & Foundry Company. These, too, lack bay windows, but boast a refrigerator and toilet-room facilities. Except for trucks and roof, which are black, the exterior is bright-red enamel with white stenciling, walls and ceiling are silver-gray and the floor is slate color.

In 1946 the Alaska Railroad bought five steel custom-built cabooses from The International Railway Car & Equip-



HOME AND OFFICE

Above is an interior view of a Chicago & North Western caboose that is listed on that line's records as Way Car No. 12104. The explanatory text on the photograph states that the car was assigned to Conductor R.W. Koch, "who kept it in 'apple-pie' order." The other picture shows a conductor and a flagman working on their reports as their caboose rolls along through the night at the end of a Seaboard Air Line fast freight.

ment Manufacturing Company. These have 3 inches of insulation, are illuminated by axle-generated electric power and, like the other models, have modern conveniences for the comfort of the men but still feature the cupola.

Improvements were made progressively, but not until 1947 did a sizable number of cabooses with bay windows make its appearance. That year, 50 cars of this type, each 41 feet long and constructed of steel, were turned over to the Southern Pacific Railroad by the American Car & Foundry Company. The bay sections have drop tables and upholstered seats that can be reversed to face the direction of movement. All in all, the conductor or trainman at such an observation post is surrounded by some of the luxury of a Pullman chair car and has a view far surpassing that from a speeding diner. With all its advantages, the bay window unquestionably marks the passing of the cupola after 70 years of service.

Only last year the Nickel Plate Road constructed a single ultramodern caboose in its Toledo, Ohio, shops. It is being used on experimental runs over the entire system, and train crews are urged to make suggestions and criticisms. It has bay windows, thus reducing the height of the car and giving it better lines. Steps, platforms and roof walk are built of nonskid steel grillwork; ladders have handrails extending well above the top of the car; and inside are electric lights and special means of ventilation.

In developing the caboose, engineering considerations must always be kept in mind. From the structural standpoint, the underframe has to be strong enough to withstand the powerful thrust of a locomotive pushing against it in helping a long train over a grade. Indeed, the Interstate Commerce Commission has long prohibited using cabooses with wood underframes ahead of pusher engines.

There is also the matter of clearance both as to height and width, because points where clearance is limited are to be found on most railroads. Some overhead bridges are lower than the standard 22 feet, measured from the top of the rail, and there are narrow places particularly at railroad bridges. Even with a cupola, height has never been a problem with the caboose, and without that superstructure it is not likely to be higher than the ordinary boxcar. But bay windows do impose restrictions as to width.

Railroad tracks are customarily only 13 feet apart, center to center. Besides, side clearance at truss bridges may be narrow. In cabooses so far built the bay windows project approximately 12 inches from the body of the car, and with the latter about 8 feet 8 inches wide, the maximum width is only 10 feet 8 inches and offers no difficulties.

The modern caboose is also far superior to the old type from a mechanical viewpoint. Although still weighing only about 25 tons, it has special trucks which not only insure riding comfort but permit it to travel at the amazing speed of 90 miles an hour. Not only that, but it is capable of long, continuous runs. For example, the new cars of the Great Northern stay in manifest freight trains from the Twin Cities in Minnesota all the way to a Pacific Coast terminal on Puget Sound.

Finally, there is the factor of safety, which always comes first on a railroad. Trainmen in early cabooses have actually been hurled through the glass in end doors when emergency brakes went on. Now a rod they can grab is within easy reach overhead and runs the entire length of the ceiling. Because there is always danger from trains that follow on the same track, the Nickel Plate's experimental caboose has a 12-volt Mars light mounted on the rear railing. It flashes on whenever the brakes are applied, casting its red beam 5 miles down the track for its own protection and that of the oncoming train.

The caboose, within its life span of 100 years, has been celebrated in speech, song and ballad. Surprisingly, there is even a charming book entitled the *Red Caboose* that was written some years ago by Mrs. Marie Ahnighito Peary Stafford —daughter of Admiral Robert E. Peary, discoverer of the North Pole, and, so far as is known, the world's most northerly born white child.

What the future holds in store for the caboose is a matter for speculation. It could be given an observation platform — it could be provided with both bay windows and a cupola — it might be equipped with television, radar, and other wonder devices yet to be invented. But most certainly the colorful car, emblazoned with the owning road's name and symbol, will keep pace with railroad progress and continue to roll along at the end of every freight train.

BAY-WINDOW CABOOSES

About 1923 one of the midwestern railroads introduced a caboose that had lost its cupola and gained bay windows, one on each side. That was the first architectural change made in cabooses in many a year and bids fair to be generally adopted in time. At the top is a bay-window car built in 1930 that retains the traditional monotone coat of paint. The other view shows the latest fashion in cabooses—a bay-window model with electric lights, radio communications system and other improvements, as well as a modernistic color scheme.

The Timekeeping Smithies of Nottingham

TIMEPIECES operating automatons, from the cuckoo clock to those of medieval Europe with elaborately carved human figures, have always been fascinating to behold when animated. They are marvels of the watchmaker's art, with intricate linkages that cause the figures, commonly known as jacks, to move or sound the hours. Although clocks of this kind are generally considered to be the product of horologists of days long gone, one was recently designed and built for Lewis & Grundy, Ltd., and installed above the entrance of its business establishment in Nottingham, England. It is a twin-faced timepiece that activates two small blacksmiths who strike an anvil with sledges in rhythm with the quarter hours and hours.

As described in *The Engineer* (London), the clock is 2 feet in diameter and suspended from a steel girder inserted into an oak beam on which the jacks, anvil and a forge are mounted. Each smith brings his hammer down once on the anvil to announce the first quarter hour, twice on the half hour, three times at the end of the third quarter and four on the hour. Immediately thereafter, one of the automatons tells the time by delivering the appropriate number of blows. The sound is much like that made by a real sledge coming down on an anvil and is reproduced by a hammer-and-ring striker concealed in the canopy of the forge.

Intricately designed with a full set of tools, the forge is provided with five electric lamps concealed in the base and ranging in color from dark red through bright red and deep, light and brilliant orange. When the time for striking approaches, the forge begins to glow faintly, the light increasing in intensity as the figures go through their paces and fading away when the operating cycle ends. When fully illuminated, the glow is visible even in daylight.

The jacks are aluminum castings attractively painted and jointed at the waist and shoulders to give the impression of real men swinging hammers. Both wear sheet-rubber aprons which, when they lift gently with the breeze or with the movement of the smiths give an added touch of realism. The clock faces are of hand-hammered copper with medieval-style numerals and hands and are set in an artistic wrought-iron frame of scrolls, leaves and flowers.

The clock mechanism is inside the building and mounted on an extension of the girder that supports the blacksmith shop. It consists essentially of reduction gearing and a clutch controlled by a synchronous motor which, in turn, is regulated by an electrical half-minute impulse precision master clock because the frequency of the alternating current available could not be depended upon to insure accurate timekeeping. The arrangement is such that the motor advances the gear train and the hands attached to it a distance equivalent to 30 seconds in about 20 seconds. Then the small clutch disengages and uncouples the motor from the reduction gearing, causing it to run free and the timepiece to remain stationary for ten seconds. At the end of the true half-minute period the master clock again comes into action, reëngaging the clutch and moving the hands forward another 30-second interval. The striking and chiming units are each driven by a fractional-horsepower motor controlled through mechanical linkages by cams on the timepiece.

The selection of a smithy as the motif for the clock is explained by the fact that Lewis & Grundy, hardware dealers, started business at its present site with a blacksmith shop, and it is interesting to note that the part of the building from which the timepiece projects stands on the site of the old forge. Like medieval figure clocks, of which fine examples in perfect running order are still to be found in Europe, the new automaton timepiece in Nottingham attracts crowds who stand and wait to see the gray-haired smith and his youthful helper strike the hours.

JACKS IN ACTION

The figures are of cast aluminum, hollowed out to permit insertion of the operating mechanism, the linkages of which pass down through one leg of each jack. The mechanical details were worked out by first using a Meccano set, similar to the American Erector set, and later a wooden model. The figures were carefully painted in various colors by a senior student of the Nottingham College of Arts and Crafts. One robot is depicted as an elderly man with gray hair and mustache and his companion as a young helper. Actual blacksmiths were studied to give the figures realism, and the tools and equipment are scale reproductions of their counterparts in industry. The clock is suspended from the oak beam on which the blacksmith shop is mounted.

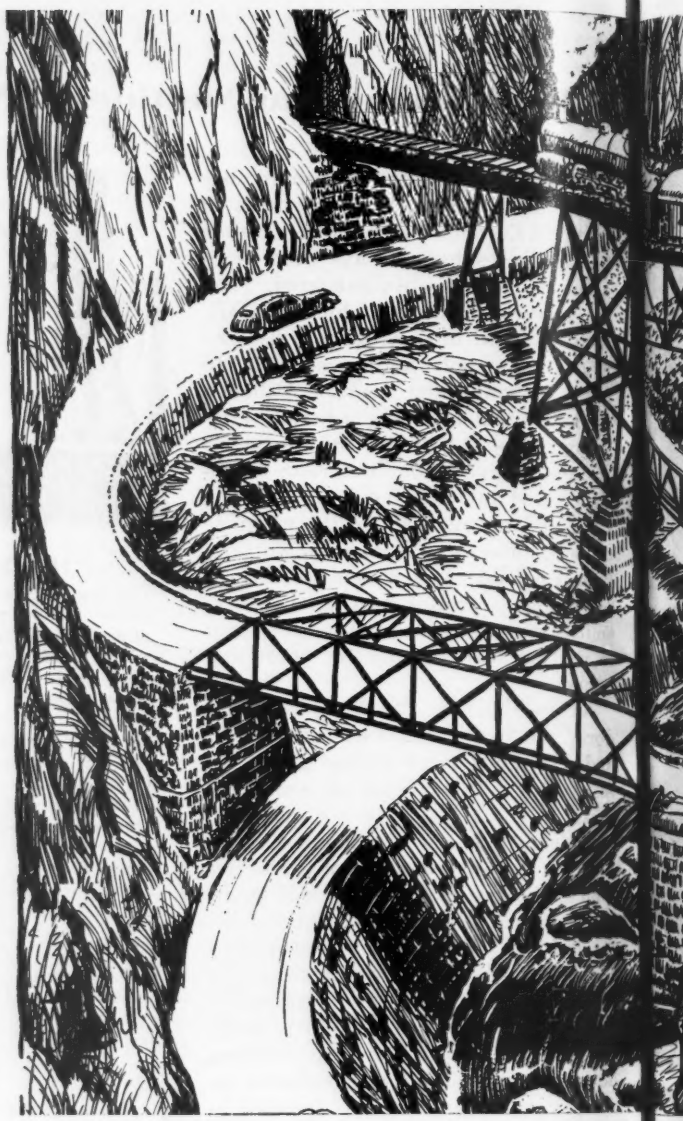
Difficult Tunneling in England

IN ITS review of civil engineering in 1952, *The Engineer*, London, describes the difficulties that were encountered in driving a sewer tunnel in the Manchester area. Operations were started in free air in 1946, suspended a year later because of unstable ground, and resumed in June, 1950, under a new contract let to Kinnear, Moodie & Company, Ltd., for the construction of the remaining 2150 yards, using compressed air as necessary. Stationary compressors with a combined capacity of 3400 cfm were set up so the working places could be put under pressure, and four portable units with a total capacity of 2600 cfm were provided as reserves.

A shaft 100 feet deep was sunk to give access to the tunnel line, and headings were opened under free air in both directions. The faces were originally in clay, but the one on the downslope ran into a seam of gravel after progressing 20 yards and necessitated halting operations while locks were built in both headings to put the workings under pressure. Air was turned on in the downslope heading and had to be continued throughout its entire length of about 400 yards.

After the upgrade face had been advanced through clay in free air for 70 yards with the aid of a shield, ground conditions required putting it under air pressure. Initially 12 psi was used, but after going 20 yards farther a full face of sand was met and the pressure had to be raised to 32 psi to exclude water. When more stable ground was reached the section that had been excavated in sand was lined with bricks while under pressure and tunneling was resumed in free air farther upslope where access was gained by sinking another shaft. Driving had progressed several hundred yards in hard clay when, without warning, water began to pour through the roof a few inches in front of the leading edge of the shield.

The miners were immediately withdrawn and the section was put under air pressure. When men entered it twenty minutes later they found that 70 cubic yards of sand had come in through a hole only 4 inches in diameter. Investigation revealed that the clay covering was only 1½ feet thick at that point and that there was a large cavity where the sand had been. As a main highway was directly overhead, the opening was successfully grouted through holes thrust in the roof.



EL INFIERNILLO (LITTLE HELL)

Showing the congestion of transport arteries in the narrow gorge of the Rimac River at a point 10,500 feet above sea level on the eastern slope of the Peruvian Andes. At the top is the 292-foot trestle, 146 feet above the plunging stream, which Henry Meiggs built to carry trains from tunnel to tunnel in the almost perpendicular side walls. Beneath it, the highway describes a serpentine course to gain 130 feet of altitude within the confined space. The figure eight, with its extensive masonry supports and two bridges, 97 and 156 feet long, was conceived and executed by Peruvian engineers. The drawing was made from a water-color painting published on the front cover of the Peruvian magazine "Ingenieria Militar" (Military Engineering) in 1950.

On the Ferrocarril of Peru

(Highest standard-gauge railroad)

Virginia Holmgren

There's a railroad that's worth the riding,
Just to say that you've followed its track,
That you've gone as high as a railroad goes—
To the "top of the world," and back.
Ferrocarril Central, they call it,
And it crosses the Andes crest,
Through the heart of Peru it beats its way,
West to east, and east to west.

'Twas a Yankee they asked to build it,
Henry Meiggs was the fellow's name.
He'd done some construction in Chile
When Peru came to hear of his fame.
"It's a job impossible," they told him.
But Meiggs said he'd give it a try,
He'd get those rails over the Andes
If he had to lay track in the sky.

So he gathered a stout crew of workers
And set out to survey the land.
They laid out each switchback and tunnel
And the crew set to work as he planned.
When they started a bridge at Verrugas
The men died of fever like flies.
And the price that Death asked for a toll fee
Was a life for each spike in the ties.

The fever was left in the valleys,
But Death kept on dogging their trail.
And Meiggs kept on building and planning
With odds three to one he would fail.
When he needed more money, he got it.
He begged and he borrowed and schemed.
Some say that he even tried stealing,
But the railroad kept on as he'd dreamed.

He zigzagged through tortuous canyons,
He tunneled and blasted and filled.
The mountain winds screamed their defiance,
But the rails somehow went as he willed.
There were many who labored beside him,
And for all there's a witness to fame—
Where the rails cross the crest of the Andes
Towers a peak with Mount Meiggs as its name.

So if it's adventure you're seeking,
There's a railroad that's waiting for you.
You can challenge the peaks of the Andes
On the Ferrocarril of Peru.

Henry Meiggs

Colossus of Andean Railroading

IN THE accompanying poem, Mrs. Virginia Holmgren, wife of an American sales engineer in Bolivia, gives a vivid word picture of the construction of a spectacular stretch of mountain railroad in Peru. She also pays tribute to the genius of Henry Meiggs, an American engineer who built the line and numerous others in Chile and Peru, often in the face of almost insurmountable obstacles.

The piece of trackage Mrs. Holmgren describes is the Central Railroad of Peru, which runs from Callao and Lima up to Oroya, crossing the Rimac River many times en route and descending southward to Huancavelica. In its 259-mile course it goes through 65 tunnels and over 67 bridges, reaching the crest of the Andes, 15,665 feet above sea level. From Oroya, high in the mountains, an 83-mile branch line extends to various prop-

erties of the Cerro de Pasco Mining Company. Before she was married, Mrs. Holmgren taught school in the elevated town of Cerro de Pasco and often traveled the railroad about which she writes.

The life story of "Enrique" Meiggs, as the South Americans knew him, reads more like fiction than fiction itself. This fabulous figure of Andean track-laying was born in 1811 in Catskill, N.Y., and grew up there. Judging from his subsequent accomplishments it would seem that he must have had some technical education, but the facts regarding his schooling are not at hand. In 1835 he went to New York City and almost immediately began to make money in lumber transactions. In two years he was prosperous, but lost everything in the panic of 1837. Two years later he had more than retrieved his losses and owned a sizable lumber yard in what is now Brooklyn. Along with his mercantile pursuits, he took an interest in music and served as president of one of the leading musical societies of the period.

He failed in business for the second time in 1842. The following six years are largely a blank, but in 1848 he sailed for San Francisco with a shipload of lumber, a commodity that was in such demand there that he was able to sell the entire cargo for twenty times its cost to him, and in gold. With the proceeds he established lumber yards, and soon was a substantial citizen. He took a hand in politics and served three terms as an alderman. However, he chose the wrong time to expand his business and again faced bankruptcy.

Before that fact became known, however, Meiggs gathered up all his readily movable belongings, put them and his family on one of his lumber boats and set sail one night unannounced. When he failed to appear at his office the next morning, employees who went to his mansion found it deserted, and before long the city learned that he had decamped.

Meiggs went first to Australia and then to Chile. Accounts are vague as to how he got started in a new line of endeavor, but he soon emerged as one of the country's leading contractors and gradually concentrated on railroad building. Among the lines he constructed was a 90-mile link between Valparaiso and Santiago. After twelve years in Chile, he left for Peru and did much to beautify Lima and improve its sanitary facilities.

He realized the need for railroads, which were, in fact, being advocated by Don Manuel Pardo, one of the greatest of all Peruvian statesmen who was to become president of the country in 1872. Some lines had been built as early as 1851, but construction was spasmodic. But under Pardo's leadership the framework of the present system took form. Others besides Meiggs made notable contributions, among them Benjamin F. Bates, another American, who paid for 15 or 16 surveys across the Andes.

But Meiggs was the dominant figure. In all, he built six lines, totaling 790 miles and costing around $125 million. The most celebrated of these is the one we are interested in, especially the stretch of 136 miles extending from Callao to Oroya. It starts at sea level, crosses a desert and then traverses a cordillera notched with deep gorges.

In 1868 Meiggs contracted with the government to construct the road in six years but died before he could carry out his promise. This has been called "the railroad among the clouds" and reaches a height only 136 feet lower than the crest of Mont Blanc in Switzerland. Great chasms of the Rimac were spanned by bridges that seem to hang in midair. In places the almost sheer canyon walls are 2000 feet high, and sometimes it was necessary to rig up aerial tramways to carry surveyors and construction crews across. Some of the tunnels enter rock faces so steep that drillers had to be let down on ropes to start operations.

From Tambo de Viso to Infiernillo, a distance of 10½ miles, the rails climb 1153 feet. At Infiernillo, which means "Little Hell" (see illustration), the line comes out of one tunnel, crosses a gorge on a bridge 146 feet above the raging Rimac and enters another tunnel in the opposite rock wall. In 14 miles from Tambo de Viso to Rio Blanco there are 22 tunnels and the road ascends 2673 feet. In another stretch, where the line rises by means of switchbacks, five distinct cuts in the mountains—two on one side of the valley and three on the other—are visible from certain vantage points below.

The large labor force included Chileans, Peruvians, Chinese and Indians, and the toll of lives was appalling. Some reports say that 15,000 succumbed. In most instances, however, the causes were beyond the control of Meiggs. The quick transition from desert and sea level heat and barometric pressure to the cold rarefied atmosphere of the highlands resulted in many cases of *soroche* or mountain fever, which was chiefly responsible for the fatalities.

During the building of the Verrugas Viaduct the men suddenly began to die like flies from a puzzling malady that was later diagnosed as a form of poisoning caused by a germ. Investigation disclosed that the infectious bacteria were carried by a biting insect. By the time a second bridge was started in the same area it had been learned that the creature was exclusively a night feeder and there was no danger of being bitten by it in the daytime. Consequently, the workers were taken down to Chosica in the valley at night and returned after sunup the next morning. That bridge was erected without the loss of a single man from the fever.

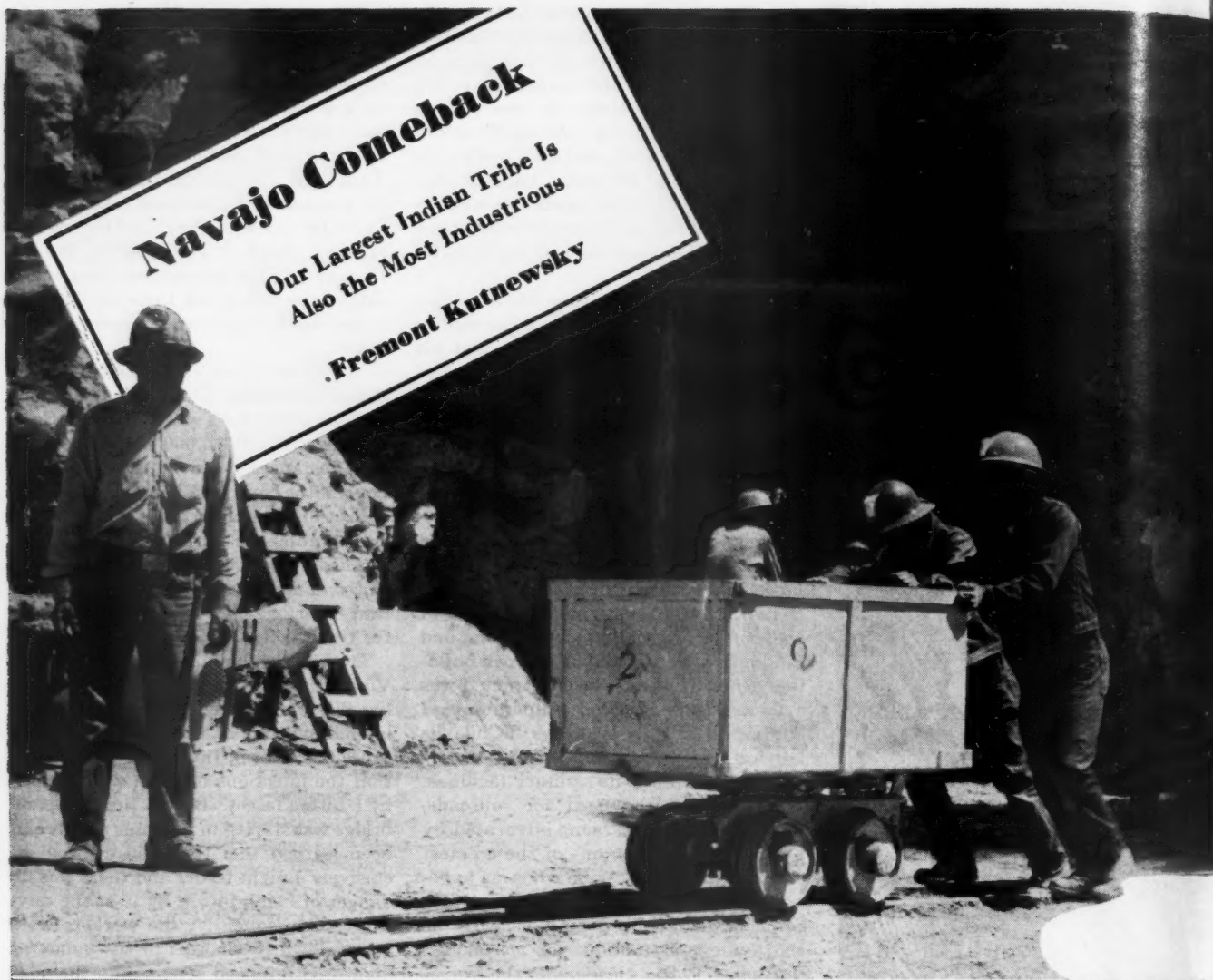
Meiggs died in Lima on September 30, 1877. He was given an impressive funeral and his body was buried 2 miles out of Callao alongside the railroad to Oroya, his greatest monument. In his will he had made provision for the completion of the line by transferring his rights in it to Michael P. Grace, one of the heads of a firm that has long played a leading part in the industrial affairs of several South American countries. After receiving confirmation from the government, Mr. Grace turned the project over to the Peruvian Corporation, an organization in which he was interested.

In addition to financing numerous philanthropies, Meiggs settled the debts he had left behind him in San Francisco long before he died and thereby removed the cloud from his name. In some cases he went far beyond his legal obligations. It is reported, for example, that he gave an elderly woman who had done washing for the family enough capital to retire on. It was sent to her in the form of bars of silver from one of the high mines served by the Ferrocarril of Peru which Mrs. Holmgren has put into verse.

Navajo Comeback

Our Largest Indian Tribe Is Also the Most Industrious

Fremont Kutnewsky



WORKING FOR OTHERS

The Santa Fe Railroad has been employing Navajo track-workers with success since 1935. During the war Navajos were recruited for other jobs and are now in demand for work of various kinds. Hundreds of families—men, women and children—help grow and harvest vegetables such as carrots, as shown in the lower picture. The boom in uranium mining on the Colorado Plateau has created openings for many of the men, who perform most of the labor on 450 claims on Navajo-owned land (top of page) and also haul most of the ore produced in the entire area to purchasing depots. Men of the tribe became pipeliners (top-right) when the El Paso Natural Gas Company extended its supply system to the San Juan gas field in New Mexico and Colorado, and many of them are still employed by it.

PHOTO LOWER-LEFT FROM N. MEX. TOURIST BUREAU, OTHERS BY MILTON SNOW, U S. INDIAN SERVICE

SOUTHWESTERNERS were surprised when the traditionally shy, reservation-bound Navajo Indians emerged during World War II as a life-saving labor pool that helped to keep civilian business going. People had grown accustomed to looking upon the Indian as tourist bait. They assumed, and he himself believed, that he would always be a misfit in the white man's world. They thought he was poor because he was lazy.

But factories, mines, commercial vegetable growers, contractors, lumber companies and railroads found him to be just what the doctor ordered when war plants in the more industrial states lured away their skilled workers. It was any port in a storm. They gave the Navajo a chance, and he made good. Not only that, but employers who used Indian labor in a pinch often decided to retain the more apt among them on their permanent pay rolls.

For example, after Navajos had been hired to build the Wingate Ordnance Depot near Gallup, N. Mex., the Army tried them out in regular work. They're still there, several hundred men and women, and they've helped the depot to win citations for safety and accuracy of operation. The El Paso Natural Gas Company employed Navajos when it laid its pipe line from New Mexico to California across Indian lands and afterwards held on to a goodly number of them in well-paid jobs.

All this may have been a revelation to many, but not to the Santa Fe Railroad which had given Navajo men twelve years of preparatory training. As early as 1935 the road hired several thousand for trackwork, and finally put many of them into its division shops as machinists, welders and helpers. Large-scale vegetable growers who started projects in New Mexico at about the same time followed suit. In this way some 15,000 to 20,000 members of the tribe gained experience beyond the confines of their reservation and proved themselves worthy of going wages. It was like breaking a spell that had held this once-proud and independent people in a backward condition for three generations.

The Navajos, with 75,000 members, are the largest United States tribe that is growing at the rate of 1500 a year. With a per capita income of approximately $300, this means a total annual income of more than $20 million of which $12 million is earned away from the reservation and $8 million by raising livestock and doing a bit of farming, mining, handicraft and business on their lands. Navajo workers are nonmigratory. They like to do seasonal work near the reservation and return home for the winter months. At that, local employment agencies say that it is no longer a matter of finding jobs for Navajos, but finding Navajos for jobs.

More important perhaps to the economy of the Southwest than this fine new labor pool, adept at all kinds of handwork and mechanics, is the program of industrialization that is building up on the reservation itself. The tribe is pushing this end of the comeback with all its resources, including some $2 million a year in revenues from oil and gas leases and royalties, license fees paid by 100 white traders on the reservation and profits from its own enterprises.

The Indians have been put in a position of doing things for themselves by two primary assists. One has resulted from the discovery of helium, oil, gas and uranium on their lands. Not only are the tribal revenues from leases and royalties providing a big boost, but the urgency of developing these natural resources has broken down a long-standing barrier to mineral exploration on the reservation. The attitude of the old-time Navajo was "Leave us alone," and the Indian Bureau has played along, keeping outsiders out.

But when uranium became a must for national welfare, when the search for it led straight to the "four-corners" country, and when the first showings of the great Colorado plateau came to light, the bars were down. Between 400 and 500 uranium claims, employing several hundred Navajos, are being actively worked on their lands today. The tribe is going into the mining business on its own account. It is now looking for other deposits including coal, copper, gypsum, kaolin, flagstone and fuller's earth that might be worth exploiting. The first systematic mineral survey ever made on the 16-million-acre reservation was carried out in 1952 by a team of geologists and mining engineers from state colleges in New Mexico and Arizona.

The other assist was the $88-million Navajo-Hopi long-range rehabilitation program adopted by Congress in 1950. This is a 10-year proposition authorizing annual appropriations for soil and water conservation and range improvement, irrigation schemes, studies of physical and human resources, development of industrial and business enterprises and opportunities for off-reservation employment, resettlement projects, roads, trails, water supply, schools, housing, hospitals and utilities. This is the most realistic approach yet to the Navajo problem, and the entire plan was more or less outlined by the Navajo Tribal Council in an appeal to the Government back in 1943.

You can't, of course, lump all Navajos together as possessing one character and quality any more than you can put all Englishmen, Frenchmen or Americans in a single category. Many are well educated, and some are comparatively wealthy. Tribal leadership has shown a strong hand for the past twenty years. The Council, composed of 72 members representing various districts in the reservation, is the governing body, but its business is mostly carried on by an executive committee headed by Sam Ahkeah, chairman.

WORKING FOR THEMSELVES
Through their Tribal Council, the Navajos have launched about twenty enterprises of their own, of which a sawmill is the most successful. It employs 225 Navajos and half a dozen whites and has built up a cash reserve exceeding one million dollars since 1947. Among other endeavors is a processing plant for wool (below) that provides raw materials for rug weavers and other handicraft workers.

In the past few years the Bureau of Indian Affairs has adopted a policy quite strange in the realm of bureaucracy. So far as possible, it has been handing over to the Tribal Council the responsibility for managing the tribe's affairs. Indian Commissioner Dillon S. Meyer announced some time ago: "We believe that within a reasonable future, if proper programming and planning are done, there should not be need for continuation of a special agency such as the Bureau of Indian Affairs." He knew, of course, that the Navajos and other Indians are ready for the responsibility, safeguarded where necessary by national law.

And the leaders have taken over with a will and with a high sense of obligation. The Council now virtually dictates how federal appropriations under the rehabilitation act shall be spent, sees to it that the work is done at the lowest possible cost, and to that end gets full cooperation from the Navajo people themselves. It has concentrated first on education. Nearly half of the 25,000 children of school age on the reservation are not being taught the three R's because there aren't enough classrooms. An effort is being made to send as many of them as possible to school along with white children under state administration. So some of the larger sums of money under the long-range program are going into schools and roads.

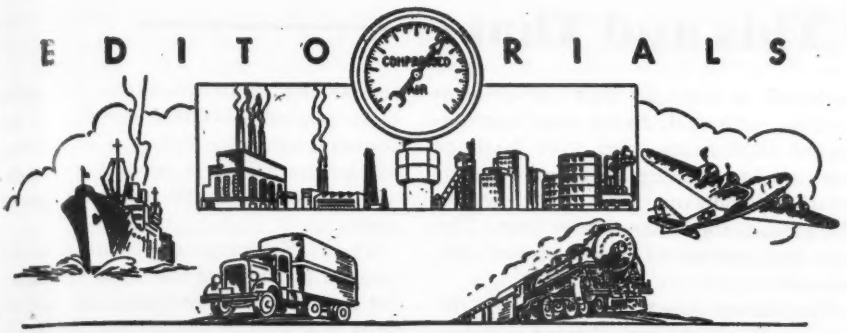
One of the first things the Council did on its own was to take over a tribal sawmill that had been run by the Bureau for many years at a loss. An experienced operator was hired, and the business yielded a million dollar cash surplus in four years. With this success under its belt, the Council lost no time when the money became available in setting up a group of tribal enterprises. In addition to the sawmill, these are: an arts and crafts guild, a furniture factory, a yarn and fabric mill, plants for making leather and cement products, two motels, three mercantile centers and a coal and several uranium mines. Some of these are in charge of well-paid men from the outside, but always with the stipulation that a Navajo understudy be trained for the management job. A $12,500 general manager supervises all the activities.

To help individual Navajos go into business for themselves, they can borrow from a revolving fund. Today they are operating 29 trading posts and nine coal and a number of uranium mines, and they also do contract hauling. The Council has ambitious plans. It foresees a string of tourist hotels with handicraft villages on the reservation. Why not take over some of this lucrative business for which the Indian has been just a prop for so many years?

Plans are under consideration for a gas-distribution system extending to fourteen Navajo communities in Arizona and New Mexico and costing approximately $500,000. In return for rights-of-way across its lands, the tribe has the privilege of tapping the California pipe line of the El Paso Natural Gas Company for a stipulated quantity of gas a day as soon as it can use it.

Movie producers would like to take advantage of the reservation's scenic spots for their "westerns," but poor means of access make the cost prohibitive. So the Council is building air strips and training young Navajos to fly to fill the transportation gap while roads are being built. And reversing the old order of whites acquiring Indian lands, the Council is out to buy several large ranches in New Mexico to take some of the people and livestock from the reservation.

From all this it appears logical that mining-equipment, general-supply and machinery companies may find the Navajos well worth watching. They are careful buyers, but they go for sound values—quality—for long-term service. They're having a lot to say about the spending of from $12 to $15 million annually under the 10-year program. Besides, there are 75,000 Navajo people approaching full participation in the American way of life, and that's no small market. Two-thirds of the families on the reservation own their own cars or pickups, and enough of them have radio sets so that a daily news broadcast from Station KGAK at Gallup serves them as a newspaper.



PREMIUM ON ENGINEERS

THE technical-school graduate continues to occupy the "driver's seat" of the industrial band wagon. The demand for engineers is still increasing, and there is no indication that it will soon begin to abate. From colleges all over the country comes the same story: Seniors are being showered with offers of jobs; they can pick the one they want. A report from the Illinois Institute of Technology states that representatives of 325 companies visited the campus to interview the 365 members of the latest graduating class. Seniors averaged 7½ interviews. Concurrently, starting salaries offered them rose to an average of about $350 monthly, as compared with $328 a year before.

Besides sending interviewers out after the boys, technically undermanned manufacturing concerns try to attract them with advertisements in school magazines. Out of 29 full-page ads in a recent issue of *Michigan Technic*, student publication of the College of Engineering, University of Michigan, 21 were direct overtures to "come to work for us," and two others touched on the subject.

At Iowa State College, Jim Hirt, editor of the *Iowa Engineer*, conducted a survey to determine which advertisements were most read and which made the greatest impression. An analysis of the 782 replies received from 2047 mailed questionnaires showed that there was a strong liking for ads that told of job opportunities. The most-read ads were those of the radio and airplane industries, indicating a preference by most of the boys to cast their lots with them.

At least two bits of current news reveal that leading companies realize they must "sell themselves" to the college graduates. If they wait for them to come knocking on their doors, they may get fooled. The mining industry in Canada is in this category: It never went in for "human relations" but knows now that it has to do so if it is to get enough technical help. The problem there is an unusual one, for when a college graduate goes to work for a mining company he is generally sent "down the hole" to start at the bottom. In no other way can he learn so quickly and so well what it is all about. However, he gets dirty and at times wet. After he cleans up at night he can find few places to visit for entertainment, because the average mining camp is small and isolated. If the boy is married, or contemplating matrimony, his wife's attitude towards the sort of life she must lead oftentimes decides whether he takes a mining job or goes where the lights are brighter.

The second revealing report comes from the chemical industry. It has almost quadrupled in productive capacity since 1939, but in the meanwhile has not more than about doubled its engineers. Automatization has, of course, cut down the need for manpower somewhat, but not to that extent. There simply aren't enough chemical engineers to go around, and they aren't getting any more numerous, as figures on graduations show. In the peak school year of 1949-50, the degree of bachelor of science in chemistry was granted to 10,800 graduates, many of them war veterans. By 1952 the number had dropped to 3800, and a look at the present student rolls indicates that not more than 5000 will be graduated in 1955. Against this supply there is a steady annual demand for from 5000 to 10,000. In an effort to increase the turnout, the Manufacturing Chemists Association last year inaugurated a "grass-roots" campaign designed to interest high-school students in the chemical field and its opportunities and thereby stimulate enrollment in college chemical-engineering courses.

The shortage of technical graduates has interesting ramifications. There is, for instance, the question of where engineering schools are going to get future faculty members. With their enticing salaries, industrial concerns are siphoning off the cream of the classes each year, and the colleges, which operate on inelastic budgets, are having a difficult time competing with them. This condition sometimes produces situations that are a bit ironical, as witness one recently brought to light at Cooper Union School of Engineering in New York City. Many of its night students are already employed in daytime engineering work. Some are studying for a degree; others are graduates taking special courses that may accelerate their advancement. Some of these students make more than $7000 a year and the average is $4214. Their teachers, however, get from $3000 to $5200 annually.

In releasing these figures, Dr. Herbert F. Roemmele, dean of students, commented: "Without suggesting in any way that industry should begin to deflate engineering salaries, I do believe that industrial leaders should realize that their material inducements are draining away competent instructors and may, in the near future, aggravate the present shortage of engineers by curtailing our facilities for training through lack of teaching personnel."

There is also the problem of when social development is going to catch up with technological advances. The airplane, telephone and radio have annihilated space and brought all parts of the earth close together physically, but they remain far apart spiritually, politically and economically. Taking this anomaly as the topic of a recent college commencement address, Philip Sporn, president of American Gas & Electric Company, one of our leading utilities concerns, disagreed with the suggestion that a moratorium be declared on scientific and engineering development until people can learn more about the important job of living together in peace and can agree on the principal phases of a universal ideology.

"The world of tomorrow we are seeking," said Mr. Sporn, "will never come into being without more engineering and more engineers. The economic condition of great masses of the human race is so bad, their daily life is so miserable, that we must first improve their material well-being before we try to kindle faith and hope in our system of freedom in their hearts. That means the use of more tools and power, the development of greater skills—in short, more and better technology."

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OUR BIRTHDAY

THIS issue marks our 57th anniversary, publication having been started in March 1896. A look at Volume One reveals that the editor was then concerned over the fact that "electricity has recently become a competitor of compressed air in that it, too, may be used in confined spaces and may be transmitted long distances and distributed."

The electric trolley "with its many disfiguring posts and network of wires," was fast ending the dream of the advocates of pneumatic transportation. Somewhat derisively, it was recorded that the Brooklyn professional baseball players got off-season base-running practice by trying to cross streets in front of the trolleys. "It took a person of much agility to escape" (being hit). That is how the team got the name of "Dodgers," which still clings to it.

This and That

Geologists Take to Helicopters

By using helicopters, a Canadian geological survey party mapped as much territory in a summer as a ground crew could cover in 25 years. Sixteen men, directed by Dr. C. S. Lord, examined approximately 57,000 square miles of terrain bordering Hudson Bay in Northwest Territories in a field season of 113 days that started last year during the spring break-up.

Most flying was done at an altitude

of about 300 feet and a speed of 30 to 40 miles per hour. Where closer inspection of rock outcrops was required for identification, "swoops" were made to within 10 feet of the ground and speed was reduced to a few miles per hour. If detailed study was called for, a landing was made.

Before the work was begun, 95 tons of gasoline, oil and provisions were delivered to three main caches while the ground was frozen. Two Hiller helicopters and a Norseman airplane were used for the survey. The plane's only job was to move camp ten times during the summer.

The various camp sites were spotted at the intersections of a rectangular grid laid out with lines forming squares 90 miles on a side. Each of these squares was flown in turn. Topographic maps had been prepared previously for each one on a scale of 2 inches to the mile with the aid of data obtained from 22,000 aerial photographs. While aloft, a geologist sitting beside the pilot jotted down geological information on his map.

A typical traverse of 90 linear miles took 3½ hours of flying time and seven hours of elapsed time, allowing for fifteen landings and the same number of "swoops." With a reasonable factor of safety, a tankful of gasoline lasted just about that long, so it was necessary to replenish at a supply depot before proceeding. All told, flying time approximated 1000 hours, and 1700 landings were made. During July and August, weather conditions kept the crews on the ground about one day in four. The cost was around $3.80 per square mile mapped.

The survey revealed that about 7700 square miles of the area charted is underlain with greenstones of Archean age, the rock in which most of Canada's important mineral discoveries have so far been made. Maps of the area will therefore be of great benefit to prospectors. Operation Keewatin, as it was termed, has proved successful in every way and will probably be followed by other helicopter surveys. Of course the method is practical only in regions where there is little or no timber.

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Robot Beer Can Inspector

Milwaukee breweries are using a novel mechanism to reject cans of beer that have not been completely filled, it is reported by the *Wall Street Journal*. A crystal of cadmium sulphide no bigger than a match head, an 8000-volt X-ray tube and a jet connected with a compressed-air line are the essential parts of the apparatus. The detecting unit straddles the final inspection line, with the crystal at the desired fill level of the tins on one side and the X-ray tube opposite it. When a can that is not full passes by, the X-ray beam moves through air instead of beer and the beams reaching the crystal are of greater than usual intensity. The extra current closes an electrical circuit that opens the air jet and a blast blows the reject off the line. The mechanism will check up to 900 cans a minute, according to General Electric Company which developed it. It can be adapted to inspect a variety of other canned and cartoned products, including milk, fruit juices, salt, cereals, oil and tooth powder, it is believed.

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Record Irrigation Tunnel

The Australian Government is preparing to drive an irrigation tunnel of record size. With a diameter of 21 feet and a length of 14 miles, it will supplant the 9-foot-diameter, 13.1-mile-long Alva B. Adams bore in Colorado as the world's largest for its designed purpose. To be called the Adaminaby, it will be a part of the Snowy Mountain development, a billion-dollar project in southeastern Australia between Canberra and Melbourne that will ultimately provide 2,860,000 kw of hydroelectric generating capacity and 2,100,000 acre-feet of impounded irrigation water. Construction will be carried on in several stages and will not be completed for about twenty years.

The U. S. Bureau of Reclamation has assisted in planning the undertaking under an agreement between the two nations executed in November, 1951. In addition, 25 Australian engineers have received training at the Bureau's Denver, Colo., engineering center. Two Bureau engineers, W. A. Dexheimer and A. B. Reeves, left in late January to help get the work underway. It is expected that bids for the driving of the main tunnel, a smaller bore, and for the erection of a small dam will be requested this spring and that construction will start next October. The Australian Government is hopeful that some large American contractors will be among the bidders. Australia will provide the funds for the entire undertaking.

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They Fly a Lot

In grandfather's day, a contractor who owned a few spans of mules was well fixed for transportation. But that, like most other things, has changed. For example, Morrison-Knudsen Company, Inc., which does its contracting on almost a global scale, owns and operates with its own pilots six multi-engine airplanes that have collectively flown more than four million miles. They are called executive planes and their main purpose is to enable officials to keep in personal touch with far-flung jobs, but other members of the firm use them on occasions and they are often

"Why can't your crew produce like Benton's downstairs?"

pressed into service to deliver much-needed men or materials to hard-to-reach locations. The work horse of the fleet is a 4-engine, 4800-hp ship that cruises at 200 miles an hour and can carry 34 passengers or seven tons of freight. In addition, the company charters smaller planes and helicopters for certain jobs. At one time during the last war the fleet grew until it numbered seventeen units. Only one fatal accident has marred the years of M-K flying.

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Seeking New Ways to Drill

There are more than 800 possible methods of drilling a hole in rock, according to a report in *Engineering & Mining Journal* on the activities of Drilling Research, Inc., a nonprofit organization formed by 40 producing and exploration companies in the oil industry. From the time of its formation in 1949 until the end of 1951, DRI spent $534,609 trying to find a new and better way of drilling. It has narrowed its investigations down to about fifteen methods and is said to be most interested now in vibration drilling, which is unexplained beyond the statement that it involves oscillating the drilling tool at the bottom of the hole with electricity. Funds have been provided to continue the research work throughout the present year.

★ ★ ★

Powdered Mashed Potatoes

Pulverized mashed potatoes are something new in the dehydrated-vegetable line. To prepare the powder for the table, you add hot water and stir, and in 20 seconds, it is said, you have fluffy, smooth potatoes possessing all the nutrient value Nature put in the original spud. So far as we know, this latest desiccated product is now being turned out only at Eslov, Sweden, by P. Hakanssons Konserver A. B., which developed the process.

The procedure consists of peeling the tubers, boiling them, and then evaporating the contained water with the aid of vacuum equipment. The full content of albumen, mineral salts and trace of fat is retained. Some vitamin C is lost but is replaced by chemical means. Packed in canisters or bags of plastic or paper, the powder will keep in good condition for up to four years, as compared with eight or nine months in the case of whole potatoes which, besides, must be stored in a cool place.

One pound of powder is equivalent to 26 pounds of potatoes. The resultant reduction in shipping charges will, it is expected, put potatoes within the means of people in almost any part of the earth. A coming boon to housewives, the powder is now being used chiefly by restaurants, institutions, the armed forces and elsewhere where the large number of people to be fed makes the peeling of potatoes an onerous job.

★ ★ ★

Research Lab 79 Years Old

Research laboratories are commonly thought to be of comparatively recent origin, but the Pennsylvania Railroad has been operating one at Altoona, Pa., since 1874. Among other things its staff of 244 does is test samples of just about everything from oranges to stone ballast that goes to make up the $300 million worth of goods the road buys annually.

According to an article in *The Pennsy*, employees' monthly magazine, laboratory technicians have even baked biscuits to check the validity of a shipper's claim that a consignment of flour had been contaminated while in the railroad's custody. The laboratory has machines for carrying out all sorts of tests, including one that determines the strength of rubber used in hose for air-brake systems. To be acceptable, a 2-inch length in the center of a longer strip must stretch to 8 inches without breaking. Included in the research staff are 100 inspectors who travel to mills, mines, forests and factories to look over materials the railroad purchases.

Ancients Used Respirators

THE accompanying picture shows a worker at the Omaha, Neb., plant of American Smelting & Refining Company dressed to clean out a baghouse cellar in which there are harmful gases. His mask is supplied with compressed air from the cylinder in front of him, a valve permits regulating the pressure, and a filter removes excess moisture.

Writing in the ASARCO Newsletter about the use of such respirators, K. W. Nelson, chief hygienist of the company, reveals that crude devices for the same purpose were originated long ago. "In the first century A. D.," he reports, "Pliny the Elder wrote of Roman red lead refiners wearing bladders over their faces to avoid inhaling dust. In 1700, Bernardo Ramazzini, often called the father of industrial medicine, recognized certain occupational diseases and recommended that workmen in dusty trades cover their mouths with shawls.

"Oxygen-breathing apparatus was introduced in the United States about 1907 and research in the field received sharp impetus ten years later when the U. S. Bureau of Mines was assigned the task of developing a mask for American soldiers. During World War I gas masks saved many lives. Afterward, industry's increased interest in accident and occupational disease prevention brought demands for specialized equipment—lighter, more comfortable dust respirators, masks with canisters for protection against each of the toxic or irritant gases, and so on."

Industrial Notes

Over-the-floor wiring is not desirable but cannot always be avoided. To protect it, as well as to prevent accidents, two telephone men have produced a "duct," together with riser and L- and T-angle fittings, that eliminates drilling holes and marring floors. Called Flexiduct, it is made of a rubber strip that has

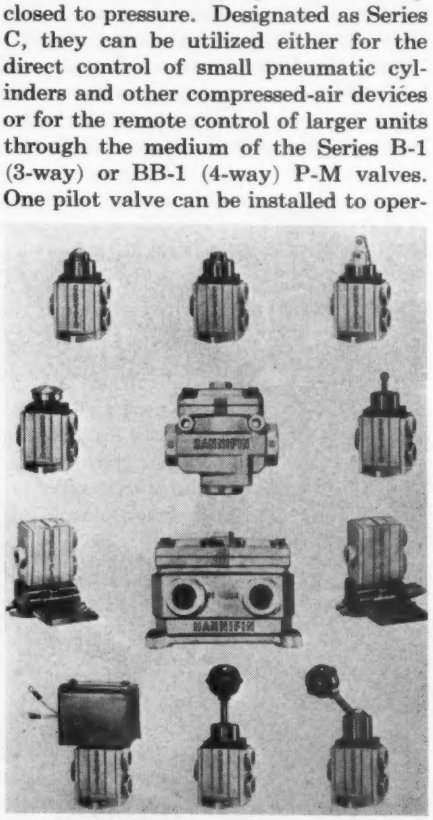
a featheredge and is 2¾ inches wide when laid and arches to a point 7/16 inch above floor level. Applied with a special cement, the flexible material adheres to all kinds of surfaces but can be easily removed by prying one end loose and pulling it up. The standard size will house from two to eight conductors of inside wiring or, with the bottom web removed, four pairs of plastic-covered wires. A special larger size will accommodate up to 25 pairs of inside-wire or switchboard cable. Flexiduct is made by Goodyear and marketed by Winders & Geist, Inc., Lincoln, Nebr.

If you need a gasket for a certain component, just squirt it on, says Dewey & Almy Chemical Company. The latter has formulated special resin compounds that are applied in liquid form onto a spinning part and then baked to provide effective seals against moisture, oils, gasoline, heat, pressure, vacuum and vibration. The result is a solid rubbery gasket that fits tight and will not fall off, it is claimed. Depending upon the size of the components, the liquid can be sprayed on semiautomatically or automatically at the rate of 300 a minute.

For compressors handling hydrogen, nitrogen, hydrocarbons, air and other gases, Carbide & Carbon Chemicals Company has developed synthetic lubricants obtainable in both water-soluble and water-insoluble series. Called Ucon brand they are polyalkylene glycols and derivatives and are supplied with or without additives in a range of viscosities from 50 to between 60,000 and 90,000 SUS at 100°F. According to the producer, they are waxfree, nontoxic, do not corrode metals or poison sulphur-sensitive calalysts and have little tendency to form varnish, sludge or carbon. For use where color is a factor, lubricants that are virtually water-white are available. Samples and technical information can be obtained by writing to the company at 30 East Forty-second Street, New York 17, N. Y.

British railways are going to construct a wind tunnel to study such things as train ventilation, dispersal of smoke and steam, wind resistance of cars in high-speed freight trains, cooling of diesel locomotives and designs of draftproof signal lamps. Air will be drawn through the tunnel at speeds up to 100 miles per hour and will be routed back to the entrance to make use of the unexpended velocity. Tests involving the use of trains and locomotives will be carried out with scale models.

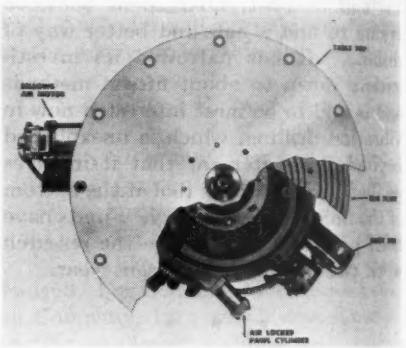
To the line of Pilot-Master valves Hannifin Corporation introduced last year has been added an assortment of ten pilot valves that can be used either 2- or 3-way normally open or normally closed to pressure. Designated as Series C, they can be utilized either for the direct control of small pneumatic cylinders and other compressed-air devices or for the remote control of larger units through the medium of the Series B-1 (3-way) or BB-1 (4-way) P-M valves. One pilot valve can be installed to operate two or more master valves or, in the case of complicated all-pneumatic circuits where cam-controlled pilot valves function like limit switches, several may be used to actuate one master valve. Basically, the ten valves in the C Series have the same 3-way, direct-operated poppet-type mechanism, are designed for a maximum pressure of 150 psi (more when water or oil is the fluid) and are usually furnished in ¼-inch size, iron pipe, with varied operating heads.



RANGE OF MODELS

Shown here are the ten Series C pilot valves which form a frame for two of the Pilot Master valves (a B-1 three-way and a BB-1 four-way) they are designed to operate.

To its line of controlled air-power devices, The Bellows Company has added an air-operated rotary index feeder that is said to position work with an accuracy of 0.001 plus or minus. The BRET-26, as it is classified, has a 26-inch-diameter table top rotated by an electrically controlled Bellows air motor (cylinder). The

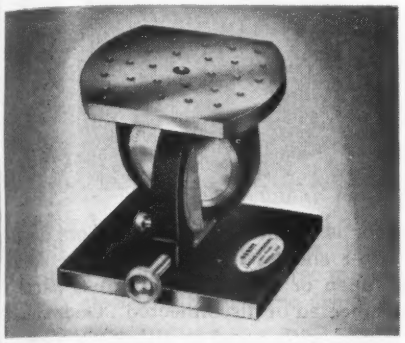


standard unit can be set to index at 6, 9, or 18 stations (additional ones are provided on request). The accuracy of the dial feeder is the result of a novel arrangement by which a tapered shot-pin is inserted successively into eighteen holes that are jig-bored at equidistant points around the perimeter of the table top and tapered and bushed to a diameter of ¾ inch. The pin is driven into position by an auxiliary air cylinder controlled by an Electroaire valve and synchronized with the movement of the table, locking it in place.

The Manegold Stone Company recently retired from a Midwest quarry two trucks that had run 60,000 miles in ten years without ever having been outside the production area. Stone is quarried in a steepsided pit that has a floor area of about 7½ acres and that is now 160 feet below the general surface level. The vehicles hauled blasted rock to a hoist that raises it to a crusher. A crane lifted the old trucks out of the quarry and lowered two new replacements.

After years of experimentation, Scientific Engineering has introduced the Derry Angle Computor, a high-precision tool that is designed to measure in degrees and seconds any simple or compound

angle within a hemispherical area on two graduated protractors which are within three seconds tolerance of arc. Pulling out the vernier release pin permits setting it to any desired angle, and precision setting is obtained by reinserting the pin. A key is provided to make adjustments. No-glare dials facilitate reading, and a clutch-type lock

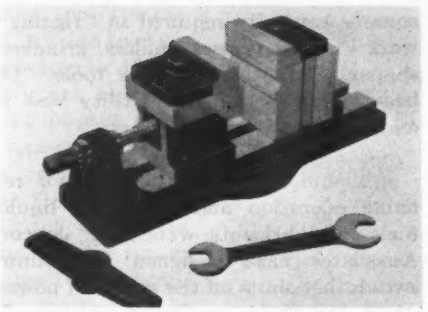


fixes an angular position for job work. The computor is said to be an invaluable aid to jig and fixtures builders, toolmakers, machine shops and aircraft and other plants where accurate measuring of angles is important.

In its new acid-leaching plant, Getchell Mine, Inc., is drying tungsten flotation concentrates in a novel manner by equipment of its own devising and manufacture. In place of a wood- or oil-fired unit to provide the heat, it uses eight infrared lamps set in a rack above a sheet-metal pan on a concrete foundation. The rack is hinged and counterweighted to facilitate raising and lowering. The advantages of a system of this kind are obvious.

Tests have proved that concrete slabs are not of uniform strength throughout because the heavy aggregate sinks during the setting period while the less-resistant laitance rises. This can be prevented by the use of an additive called Plastiment which is said to promote adhesion between the aggregate and the cement-water paste, thus increasing surface hardness more than 25 percent, depending upon the thickness and richness of the concrete and the slump. The material is a product of Sika Chemical Corporation, Passaic, N. J.

"Only disadvantage of our line, Sir, is the personnel problem. With the profits you'll make, your entire staff will be able to retire every six months."



What is described as a four-in-one vise has been announced by Brown Engineering Company. The rear turret of the unit revolves, offering four different faces for holding round, square, octagonal, rectangular, flat or angular pieces vertically, horizontally or at an angle. Auxiliary jaws at the top of each turret can be spread to grip odd-shaped parts. All components necessary for clamping are included, eliminating the use of bolts, washers, parallel strips, levels and

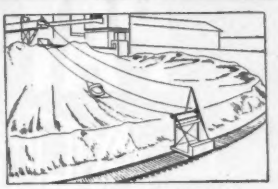
Picture shows a 400-ft. span Sauerman Drag Scraper machine, powered by a 150 h.p. motor, backfilling an empty stope at a large nickel mine in Canada. Scraper cuts into side of hill and moves earth down to a raise at rate of 2,000 cu. yd. a day.

Slash your handling costs with a

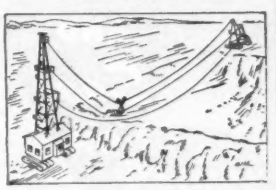
SAUERMAN SCRAPER

In a Sauerman Drag Scraper Machine you find a profitable combination of digging power, haulage speed, long reach, simple operation, economical maintenance.

An important exclusive feature of the Sauerman scraper machine is the Crescent scraper. Because of its streamline design, the "Crescent" requires less linepull than any other type of scraper of equal capacity, both in excavating and in conveying. It penetrates hard material with the ease of a plowshare, gathers a full load in a few seconds, then rides its load speedily to the dumping point where it makes an instantaneous, clean dump.



Sauerman Scraper Stockpiler



Mobile Scraper with Towers

Sketches above show two of the many types of Sauerman Scraper Machines for different material-handling requirements.

The operator, sitting in a comfortable control station, easily guides the scraper over a large area. Automatic shifting of the tail end of the machine is provided where desired. Power requirement—electric, gasoline or diesel—is moderate. Installation and upkeep costs are surprisingly low. Made in a wide range of sizes covering the capacity needs of large and small projects.

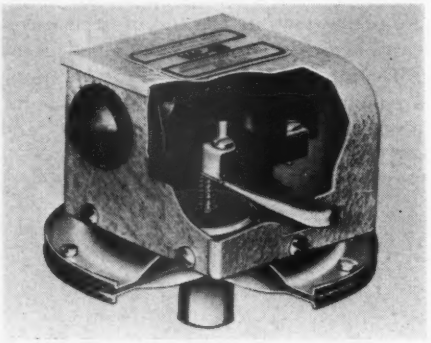
Write for Sauerman Catalogs A and E, showing how to use drag scrapers most effectively for pit excavation, stripping, pond cleaning; stockpiling, etc.

SAUERMAN BROS., INC.

548 S. Clinton St. Chicago 7, Illinois

squares generally required in "rigging" work on drill presses, millers, grinders, shapers and other machine tools. Of heavy construction, the Utility Vise is available in two sizes.

For equipment that depends for reliable operation and safety on liquid fuels and lubricants, water, etc., Jaycon Associates have designed a vacuum switch that shuts off the source of power when the fluid supply is exhausted.



Called the Vac-on, it also serves as a warning control where operations depend on a vacuum (vacuum firing in ceramics manufacture, for example). The switch is interposed in the suction line and wired into the power line of an electric motor or the spark system of a gasoline engine. When the suction falls below a predetermined negative pressure (approximately 1 inch of mercury), the switch automatically cuts off the power. The motor model is suitable for use with units of ½ hp on d-c and up to 2 hp on a-c. The Vac-on operates on the spring-loaded rubber-diaphragm principle and has silver contact points for heavy-duty service. A hand lever is provided for manual restarting.

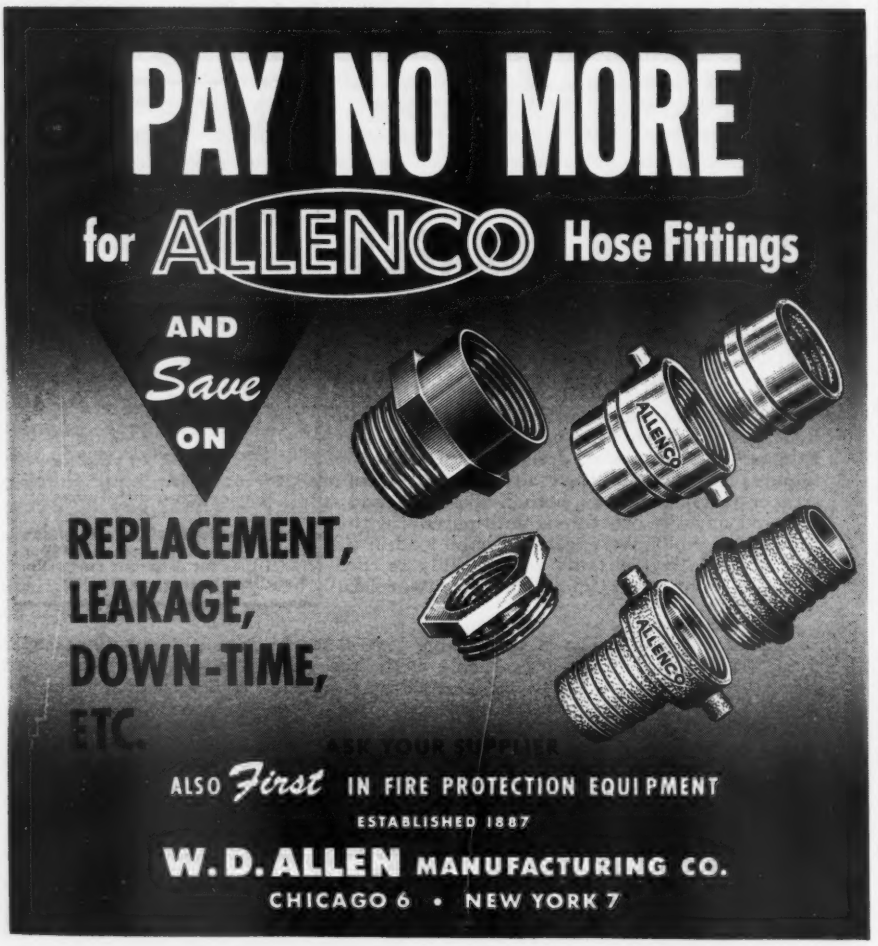
Istanbul, Turkey, is planning an underground railway. The low bid of about $60,000,000 for its construction, received from a French contractor, is being studied. The proposed subway will provide transportation between the Beyoglu and Fatih districts and relieve congestion on trolleys and buses that cross the Galata Bridge over the Golden Horn. The city now has a token "subway," a 2-station line that saves riders a steep climb from Galata to Beyoglu.

Convenience and safety prompted the Electric Machinery Mfg. Company to develop a high-voltage fuse compartment with a movable panel on which current-limiting fuses are gang-mounted. Opening the door, pulls the panel forward, thus disconnecting it from the line and enabling the operator to replace fuses without a hook stick. Mechanical and electrical interlocks prevent disconnecting the fuses when the switch is closed and closing the motor switch when the

door is open. Target indicators on the latter show whether the motor switch is open or closed and the fuse panel is connected or disconnected. Door can be locked with panel in either position.

For close-tolerance work that is apt to cause eyestrain, or where inspection calls for magnification, Armco Mercantile Company is making spectacles that are based on the same principle as a telescope or a pair of binoculars and give 2x magnification.

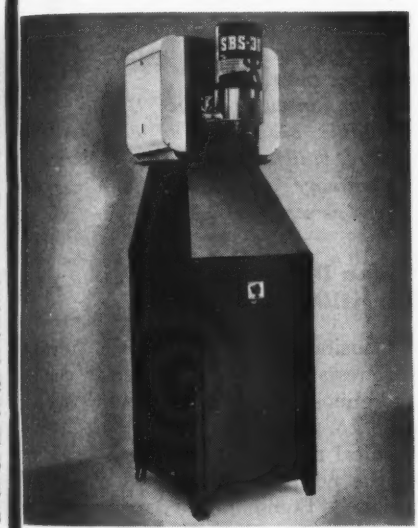
No matter how bad the odor in kitchen, laboratory, industrial area and elsewhere in confined spaces, it can be destroyed, it is claimed, not by counteracting chemicals but by an electronic deodorizer that is plugged into an ordinary circuit. Less than 7 inches high and 5⅝ inches wide, the unit houses two Westinghouse Odorout bulbs that emit light rays on a wave length that turns the oxygen in the air into ozonate. When the latter comes in contact with an odor, the two combine, with the result that the odor is completely oxidized—burned up—leaving the air smelling fresh. The



"All right, wise guy, pick it up!"

bulbs are replaceable and give six month's service if used continuously. The Rid-All Double-Bulb Deodorizer is made by Abbeon Supply Company and is capable of treating a space up to 1800 cubic feet in size.

For industrial and field use there is now available a portable washstand that needs no water and no plumbing, advantages in plants and areas where washroom facilities are inadequate or lacking. It has recently been announced by the Sugar Beet Products Company after several years of testing under service conditions and promises to be especially useful where workers encounter heavy greases, oils, paints and similar hard-to-remove fluids or compounds. Called the SBS Waterless Washstation, it is complete in itself. On the turret top of the gauge-steel stand are three dispens-



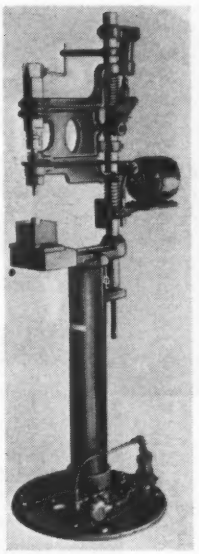
ers, two for standard-size paper towels and one for a special skin cleanser, with spacious storage space inside for both. The cleanser container is secured to the dispenser base and is discarded for a new one when empty. Accessible by a hinged door in the bottom of the washstation is a canvas receiver for discarded towels.

Metals can be mitered right on the job with a 2-pound hand-operated tool called Metalmitre announced by Lander & Abbott. By squeezing its two handles together, sufficient leverage is obtained to notch or miter nonhardened steel up to 1/32 inch thick and copper and aluminum with a maximum thickness of 1/16 inch. Interchangeable dies are provided. The tool is said to make clean accurate cuts also in molding, fiberboard, plastics and masonite.

For filling pits, blowholes and fractures in castings, as well as seams and imperfections in metal assemblies, there is available a powdered aluminum in nonsoluble liquid form that is applied with a putty knife in the semifluid state in which it is supplied or brushed or sprayed on when thinned with a solvent furnished by the manufacturer, A. L. Okun Company. It is claimed that the vehicle evaporates quickly and leaves a smooth deposit of aluminum that will not crack, chip, peel or shrink on wood as well as all metals, even aluminum. Because of its properties it may also be used for stopping gas, water, oil or similar leaks.

Phos-Copper is the name of an alloy that is marketed in paste, wire, rod, ring and strip form to meet the varied needs of copper and copper-alloy brazing operations. The paste is obtainable in 1-pound collapsible tubes or in 5- and 30-pound cans and consists of a finely powdered alloy of copper and phosphorus suspended in petroleum jelly. Of low melting point and free-flowing, it penetrates tight-fitting joints and is said to insure a strong, ductile bond. It is also suitable for resistance brazing where it can be applied in advance. Rods and wires range from 1/16 to 1/4 inch in diameter. Phos-Copper is made by Westinghouse Electric Corporation.

High-production precision riveting of all kinds of materials is achieved, it is claimed, with the improved model Airflex pneumatic riveter recently announced by Lemert Engineering Company, Inc. The machine features a new spindle that is designed to minimize impact noise, a hammer that can be regulated to vary the force and rapidity of the impacts, and an air timing valve that controls the duration of the blows. For example, a job might require 40-pound impacts (range, 5 to 80 psi) for a period of two seconds (minimum 5/10second) at the rate of 10,000 blows per minute (range 6000 to 16,000). Operated by a pedal, the hammer strikes against a motor-rotated peen which distributes the blows around the rivet head, thus lessening the possibility of bent rivets, improperly formed heads, flaking metal, loose joints, etc. Airflex riveters are available in a wide range of sizes and capacities and in two types: the standard vertical model in floor or bench style for general riveting and the double-end model that heads both ends of a rivet at the same time. Manually controlled units also are available.



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HEAVY-DUTY
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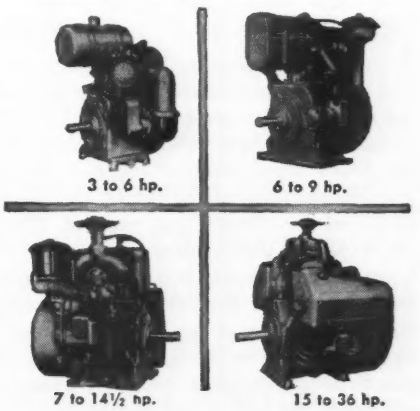

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Specified as integral power units by more than 500 original equipment manufacturers . . .

Delivering dependable, efficient power on a greater variety of service applications than all other makes of engines combined, in a 3 to 36 hp. range . . .

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Constantly demonstrating the outstanding efficiency and trouble-free dependability of AIR-COOLING . . .

These are some of the factors worth considering in the selection of engine power for YOUR equipment. Detailed engineering data and descriptive literature on request.

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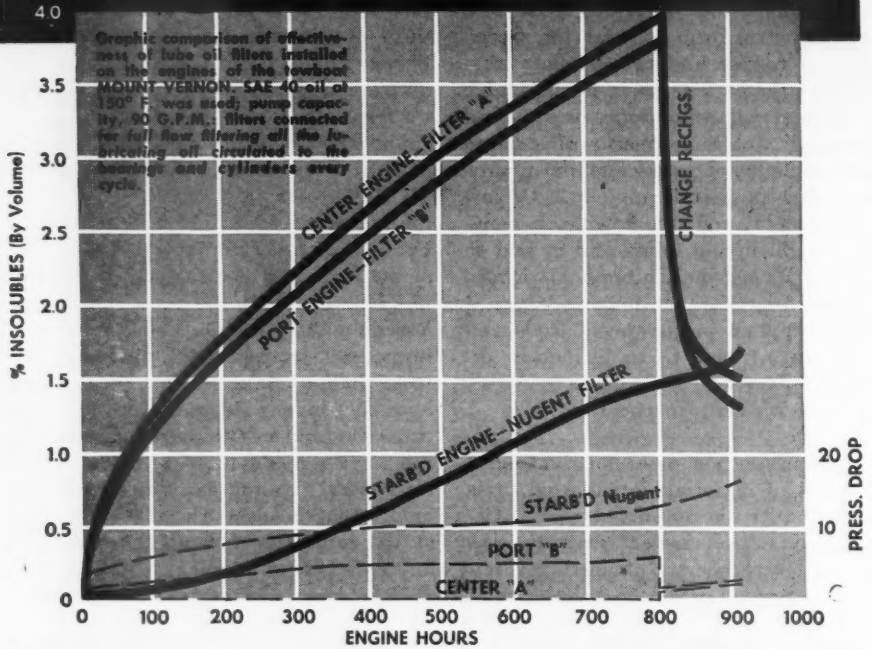
Side-by-side Comparison under operating conditions proves the superiority of NUGENT Filters



IN order to unquestionably determine the relative effectiveness of three leading lube oil filters, the owners of the towboat, MOUNT VERNON, installed a different make of filter on each of the boat's three identical engines. At regular intervals for 800 engine hours, the cleanliness of the oil was checked and recorded. The graph above shows the results—at the end of 800 hours the oil that was Nugent filtered contained less than half the concentration of insolubles as the more effective of the other two filters. Note, too, that oil passing through the other two filters was dirtier in 200 hours than the Nugent filtered oil was at the end of 800 hours.

Nugent filtering will give you this effectiveness, too. It will add to the life of your engines by reducing the amount of harmful impurities that reach vital working parts. It will extend the life of lube oil by keeping it cleaner longer.

For full information on how Nugent filtering can help you, write, outlining your filtering problem. Descriptive literature on Nugent filters is also available on request.

Nugent filter of the type used in the test aboard the MOUNT VERNON.

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Wm. W. Nugent & Co., Inc.

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QUOTES

—FROM HERE AND THERE

Conveying Metal Chips with Air

"Aluminum chips (resulting from crushing scrap previously received by railroad or truck) are delivered . . . by a pneumatic pressurized system to any one of six storage bins, which can hold about 240 tons of the metal. A second pneumatic conveyor system, of the vacuum type, sucks the chips from a storage bin when needed to a hopper-type scale. Then a discharge gate actuated by an air cylinder automatically opens and discharges the weighed material into a surge hopper. By a helical feeder, the chips are fed into the air stream of a third pneumatic conveyor, of the pressure type. Capacity of the three-part pneumatic system is 5000 pounds of aluminum per hour."

From an account in "Greater Philadelphia Magazine" of a new smelter being built by The George Salls Metals Company, Inc., for reclaiming nonferrous scrap.

"Man Does Not Die He Kills Himself"

"Business people . . . are burdened with responsibilities, confused by politics and philosophies and isms and have little time to give thought to their health. Medical men are constantly warning us of the need of realizing early signs of fatigue. Being fidgety, restless, impatient over small matters are the signs that you may be heading for serious trouble.

"Give your body a break. Treat it at least as you would a production machine in your shop.

"Accidents are something else. They are the leading cause of lost working years of life. One death in four is caused by accidents. You do not need a doctor, surgeon or scientist to prevent accidents. Common sense, some thought in your daily occupation and at your home or in your travels will stop the terrific economic loss that occurs in our country every year.

"Your resolution of 1953 should be: Have a physical checkup. Be safe!"

Harry N. Crowder, Easton, Pa., president of Lehigh Valley Safety Council.

Saving Water

"Boeing Airplane Co. here (Wichita, Kans.) is finding water conservation in its plants is saving $350 a month. And when all work currently under way is completed that saving is expected to climb to more than $1300 monthly.

"The major saving has been the in-

stallation of thermostatically controlled valves on the cooling systems of . . . air compressors, degreasers and heavy presses. Formerly water . . . entered the systems at 64°F. and came out scarcely warmed . . . . Now the thermostats don't let it pour down the drain until its temperature has reached 80 degrees in the heavy presses, 110 degrees in the compressors and 120 degrees in the degreasers.

". . . A pair of compressors that formerly sent a million gallons of water a month into sewers now send only a quarter of a million.

"Devices yet to be installed include a mechanical water chilling system for each machine requiring water cooling. After water has absorbed all the heat it can from air compressors . . . and other machines, it will be chilled and recirculated over and over."

Wall Street Journal, December 11, 1952

Nation Spends $1 in Every $8 for Construction

"Last year the construction industry once again established a new record in the volume of new construction put in place in the continental United States of $32.2 billion. To this can be added the volume of maintenance and repair operations, which brings the grand total to more than $42 billion. For the third consecutive year the volume of construction has been greater than agricultural production.

". . . This year, according to the best estimates . . . new construction can rise to $33.5 billion, with maintenance and repair operations bringing the total close to $44 billion.

"The long-range prospects . . . also are good. The backlog of identifiable projects known to be in the planning stage but not yet under construction exceeds $68 billion."

Arthur S. Horner, president of The Associated General Contractors of America, Inc.

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Books and Industrial Literature

Industrial Safety and Health Handbook is the title of an 800-page work that is said to represent the first complete coverage of the field. Published by Manufacturers Directory Company, it deals with every phase of the subject from administration and housekeeping to protective equipment, mechanical safety, skin diseases, metal poisoning, airborne hazards, solvents, radioactivity and fire protection. It is bound in a sturdy extension binder and indexed by aid of identifying tabs and labels for easy reference. The book was written and edited by Occupational Hazards, Inc., an affiliate of Manufacturers Directory Company, 1240 Ontario Street, Cleveland 13, Ohio. Price, $25.00.

Specifications and dimensions of Lunkenheimer's new gland-type needle valves for use where "eye-dropper" control of flow is required are dealt with in Circular 568 that can be obtained by addressing a request to The Lunkenheimer Company, Cincinnati 14, Ohio.

A 4-page folder issued by Stryker Machine Products Company, 197 John Fitch Way, Trenton, N. J., gives full information about its plant and facilities for the production of machined parts as well as for processing (heat-treating, welding, grinding, plating, etc.) any job from start to finish.

V. D. Anderson Company, 1935 West Ninety-sixth Street, Cleveland 2, Ohio, is distributing a new 8-page folder on its line of Hi-eF Purifiers or mechanical separators for cleaning steam, vapor, compressed air and other gases. As a guide to users the book contains installation views, piping layouts and selection tables.

Two new publications on *Annealing of Malleable Iron* (GEA-5797) and *Heat-treating Equipment for Aluminum* (GEA-5912) are obtainable from General Electric Company, Schenectady 5, N. Y. The first in a series of modern metal-processing books, they describe the latest methods and equipment used in the respective fields covered.

A new 20-page catalogue digest distributed without charge by The Ohio Injector Company, Wadsworth, Ohio, describes and illustrates its line of bronze, iron, cast- and forged-steel globe, gate, angle, check and needle valves, together with their accessories. The catalogue also contains pressure-temperature rating and trim charts.

A 4-page bulletin describing a new lubricant for application where temperatures reach 500° or higher has been released by E.F. Houghton & Company, 303 West Lehigh Avenue, Philadelphia 33, Pa. *Hi-Temp Oils*, as the folder is entitled, contains additional information about testing the lubricant, and is available on request.

Metallizing Engineering Company, Inc., 38-14 Thirtieth Street, Long Island City 1, N. Y., has announced the availability of an illustrated bulletin (62B) which describes the application to iron and steel structures of eighteen basic engineering specifications that will, it is claimed, protect them against corrosion for from 25 to 30 years.

American Brass Company, Waterbury 20, Conn., is distributing a 12-page booklet that describes the physical properties of Formbrite, a relatively new metal which

is said to be stronger, harder and springier than the usual drawing brasses. Helpful data on press- and finishing-room procedures are included, as well as case histories of applications. Ask for Publication B-39.

The 1952-53 edition of a bulletin relating to industrial humidification is being distributed by Abbeon Supply Company, 179-15 Jamaica Avenue, Jamaica, N. Y. It covers a wide variety of humidity factors, their importance, and methods of solving the problems. The publication is available in different forms to meet the needs of specific industries such as paper and printing, leather, textiles, tobacco, etc.

A new catalogue published by Chicago Forging & Manufacturing Company, 2000 Southport Avenue, Chicago 14, Ill., deals with its line of Sealastic metal fittings for tubing and piping. The shock-absorbing and vibration- and fatigue-proof fittings have been used mainly for aircraft fuel systems and oil pipe lines but have been adapted for general industrial application. The booklet is available on request to the manufacturer.

Demineralization and silica removal by ion exchange is the subject matter treated in Bulletin 3803 offered by The Permutit Company, 330 West Forty-second Street, New York 36, N. Y. The aim of the 28-page book is to help explain one of the newer roles ion exchangers are playing in industry and to describe their principles of operation, design features and chief applications. Copies may be obtained upon request.

Johns-Manville, 22 East Fortieth Street, New York 16, N. Y., has published a 52-page brochure entitled *Insulation Specifications for Oil Refineries and Chemical Process Plants*. For easy reference, the specifications are divided into four sections: those for application below 100°F, above that temperature, for tanks and for oil heaters. Space is also devoted to Manville's complete insulation service. Copies may be obtained by writing to the company.

Our Latchstring is Out and *Vacuum, the Magic Hat of Industry* are two pieces of literature that interested readers can obtain upon request to Ingersoll-Rand Company, 11 Broadway, New York 4, N. Y. Designated as Forms 300 and 164, respectively, the first deals with the company's plants, products and history; the second, a reprint of an article that appeared in the September, 1951, issue of Compressed Air Magazine, describes the varied uses of vacuum and methods of producing it.

A recent publication issued by Minneapolis-Honeywell Regulator Company, Wayne and Windrim Avenues, Station 64, Philadelphia 44, Pa., describes its ElectroniK non-control precision instruments using potentiometers, Wheatstone bridges or other electrical circuits for measuring temperature, pressure, pH, flow and other variables. Detailed specifications for each are given, as well as information on special-purpose models. Ask for Catalogue No. 1520.

A products catalogue recently released for free distribution by Arthur D. Little Corporation, 30 Memorial Drive, Cambridge 42, Mass., summarizes that firm's activities in the manufacture, handling and storing of liquefied gases such as helium, hydrogen and oxygen. Several pages of the 23-page illustrated book are devoted to a new high-field strength electromagnet for research work and to a review of the prototype development service the organization offers industrial and other concerns.

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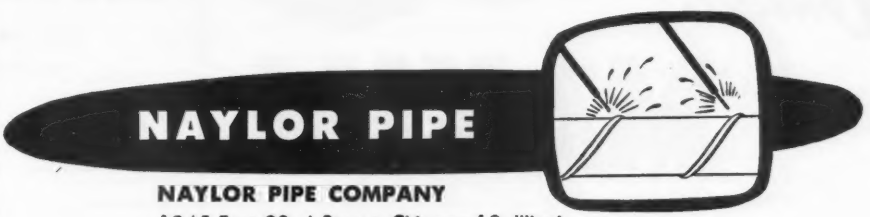

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